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ABSTRACT

This study examined the impact on learning of the integration of computer-based technology (CBT). The study focused on six New South Wales (Australia) government schools that were at different stages of development of the integration of CBT. Data were gathered through classroom observations and structured interviews with key personnel, students, parents, and other stakeholders. Findings are presented in relation to: (1) issues faced, including the importance of the school's technology vision statement, the importance of involved leadership and succession planning, and the need for technical support; (2) strategies adopted, including getting started with a whole school project and collegial approaches to professional development; (3) views of key stakeholders, including teachers' understanding of the influence of computer-based learning and student's use of computers; (4) examples of the current use of CBT, including multimedia project work and the use of e-mail to enhance learning; (5) the CBL integration threshold; and (6) classroom observations and their interpretation. The processes that underpin curriculum change related to the integration of CBT are analyzed in four major areas--external context, milieu, learning programs, and leadership. Appendices include the teacher interview schedule, the classroom observation schedule, and a sample letter to principals. (Contains 64 references.) (MES)

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Net Gain?

The integration of computer-based learning in six NSW government schools, 2000

Debra Hayes, Sandy Schuck, Gilda Segal, Joanne Dwyer and Celina McEwen

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1. Executive Summary

We have raised the question *Net Gain?* in our title to focus critical attention on the common assumption that the integration of computer-based learning in schools is a good thing. This question also points to heightened expectations for learning outcomes associated with increased use of the Internet. Our analysis details information gathered during 2000 when we visited six government schools at different stages of development of integrating computer-based technology. The information is drawn from interviews and classroom observations that had a number of purposes as listed below in section 1.1. However, our primary focus was to describe the impact on learning of the integration of computer based technology. Hence, our approach is underpinned by the following principles:

- The most important factor affecting the learning outcomes of computer-based technology applications is not the kind of technology used, but the design of the learning experience which makes use of these applications (Alexander and McKenzie, 1998).

  This assumption informed our selection of interview questions and our inclusion of classroom observations in order to broaden the scope of information collected during the school visits and to focus the collection of data on describing the forms of computer-based learning evident in each school.

- Learning programs that require students to think, to develop in-depth understanding, and to apply academic learning to important, realistic problems boost student achievement equitably for students from all social backgrounds (Newman and Wehlage, 1995).

  This assumption informed our approach to the classroom observations. Classrooms are complex systems and are therefore difficult to describe. We do not claim that our observation instrument produces a complete picture of the classrooms we visited, or that it provides a complete picture of the range of pedagogies the teachers in the study generally

utilise in their classrooms. However, we suggest that it does provide some insight into the types of computer-based learning programs currently in use in some classrooms in the participating schools.

- Change in education may be conceptualised as a process in which the external context of schooling interacts with local influences, is mediated by leadership, and impacts upon learning programs. (Scott, 1999).

  This assumption informed our attempts to describe the forms of leadership, school organisational structures and external supports that contribute to effective integration of *computer-based learning* (CBL) in classrooms.

Throughout this report we use the term *computer-based learning* (CBL) in preference to other terms, such as information and communication technologies (ICT) to emphasise our focus on learning mediated by technology. We also interpret the scope of technologies described by the term *computer-based technology* (CBT) broadly to include the Internet, Intranets, email, CD ROMs, software packages and other forms of educational technologies.

1.1. Background

This research was commissioned by the Curriculum Support Directorate of the NSW Department of Education and Training (DET) and undertaken by the Change and Education Research Group (CERG) at the University of Technology, Sydney (UTS) for the purposes of:

- Listing recommendations that will inform future directions in the provision of curriculum support to assist with the integration of computer-based technologies in NSW (see section 1.2);

- Producing a detailed and current literature review highlighting key points pertinent to the focus of investigation of the project (see section 3);

- Identifying the issues faced by a range of government schools at different stages of integrating computer-based technologies across the curriculum (see section 4.1);
- Documenting a range of strategies adopted by different types of government schools in integrating computer-based technologies across the curriculum (see section 4.2);
- Synthesising the views of key stakeholders involved in the integration of computer-based technologies across the curriculum (see section 4.3);
- Producing rich descriptions of the current use of computer-based technologies for teaching and learning in schools (see section 4.4);
- Interpreting the principles of learning and other beliefs which underpin the use of computer-based technologies in teaching and learning (see section 5.2);
- Analysing the processes that underpin different school communities' approaches to curriculum change focusing on the integration of computer-based technologies across the curriculum (see section 6).

The approach we took to the collection of the data is described in section 2.

1.2. Key findings and recommendations

The six government schools we visited were utilising their human, financial and physical resources in innovative ways in response to a range of local contexts. The detailed descriptions contained in this report provide insight into the complex circumstances surrounding the integration of computer-based technology in the participating schools.

Key findings from our observations in the participating schools are grouped into three categories:

a) Issues faced;

b) Strategies adopted;

c) Teaching practices observed.

1.2.a. Issues faced

We identified three key findings related to the issues faced by a range of government schools at different stages of their development in integrating computer-based technologies across the curriculum:

Key finding 1: The integration of CBL in schools is enhanced by the existence of Technology Vision Statements

The importance of a consistent vision that articulates the integration of computer-based learning with other elements of the curriculum has been identified by previous studies (see for example Wright, 1994 and Tavalin & Gibson, 2000). We observed a number of schools where a consistent vision had been established as a result of the development of a Technology Vision Statement. In schools where these statements had been developed we noted that the executive appeared more able to articulate a clear vision for technology integration. The following statements were made by members of the executive in schools that had developed a technology vision statement:

> *The vision for computer-based learning within the school is that children understand that it is just part of normal work and normal life. (Principal)*
>
> *The ultimate goal is to get everyone using it as a tool rather than as an add-on. (Computer coordinator)*
>
> *A part of the "vision was to empower staff to become lifelong learners ... especially in technology where it's changing so rapidly ... and to have all staff and students using technology. (Principal)*

One principal described the situation prior to the development of their statement as, "very haphazard, depending on the teachers' capabilities and interests". Although schools approached the development of these statements in varying ways, they generally detailed plans for achieving various educational objectives such as empowering students in their use of technology, enhancing learning through technology and enhancing administrative procedures.

We recommend that support be given to all schools to develop a Technology Vision Statement that reflects a shared vision for learning.

Key finding 2: Leadership is critical to the successful integration of computer-based learning

Previous studies have highlighted the importance of leadership in supporting the process of integrating computer-based learning. For example, Treagust and Rennie (1993) pointed to the need for continuous coordination and Sherry, Lawyer-Brook and Black (1997) focused on the importance of vision and support for technology. Also, the NSW Audit Office (2000) made a connection between leadership and vision by claiming that a school is likely to be more technologically advanced with leadership that "articulates a clear vision for the use of computers in teaching and learning" (p. 63).

Our observations lend weight to the general consensus that leadership is an essential element of the integration process. We observed different forms of leadership, including integration processes led by the executive, committees, and enthusiastic teachers operating solo, but the most significant was the active involvement and support of the principal.

We recommend that principals, and other leaders of learning, be supported to actively lead the integration of CBL in their schools.

Key finding 3: Successful integration of CBL is supported by accessible technical support

Whilst this study focussed on how technology is being integrated into learning programs, we were continually alerted to the need for computers to be well maintained and for teachers to have access to technical support. It is clear from our observations that functioning computers, and "fast fixes" when they break down, are essential to effective computer-based learning integration. One teacher explained the situation in her school in the following way:

> *There's a constant maintenance problem because things go wrong - just bits and pieces. But you have to be able to resolve those problems yourself. You've really got to become adept at sort of understanding your own computers. And you tend to if you have them long enough.*

Our findings echo the observations made by the Audit Office (2000) in its report into computers in NSW government schools. It observed variations in the ratio of computers to students; significant variation in the extent of technical support; variations in the amount and type of software available for student use; and some schools had significantly greater capacity to fund computers than others.

We recommend that the NSW DET put in place mechanisms to ensure that schools have access to technical support that facilitates their effective use of computers.

1.2.b. Strategies adopted

We observed a number of strategies that were adopted by different types of government schools in integrating computer-based technologies across the curriculum. We were particularly impressed by the benefits of whole school approaches, as described below. In this section we also propose two recommendations related to this finding.

Key finding 4: Whole school projects have the potential to mobilise broad-based support for the integration of CBL

A clear benefit of whole school approaches is the involvement of multiple stakeholders in the process of computer-based learning integration. This relieves a small group of people, or an individual, from bearing responsibility for carrying out the process of integration and encourages a degree of commitment from all stakeholders. One principal described this as "a hands-joined approach":

> *We all went to the side of the cliff, held hands and jumped...but I had confidence that the staff would (float). There's enough trailblazers to give us buoyancy and linking the hands really made people more buoyant.*

From our observations, we believe that computer-based learning integration requires fundamental shifts in the core activities of the school. These shifts include new teaching practices and new agreements about how resources are distributed. A whole school approach supports successful integration because it requires all teachers to be involved in the process; encouraging a sense of ownership and support for a smoother integration. Previous studies also noted the importance of such collaborations. For example, Wright (1994) stated that it is essential for teachers and administrators to collaborate in developing and integrating effective technology education programs (see also Means, 1994; Dwyer, 1996; Saye, 1997; Davis, 1997; and, Dockstader, 1999).

We recommend that schools utilise whole school approaches to the integration of CBL which incorporate a range of strategies to actively involve the whole school community in the process of integration.

Whole school approaches appear to be particularly effective when they support opportunities to enhance teachers' sense of belonging to a professional learning community. One classroom teacher summed this up in the following way:

> *I think it's that knowing each other makes a difference. It wasn't like someone outside coming in and saying, "You do this". I sort of said "Oh, I've got an idea for your outback class, do you want to have a play with it?" And it was introduced that way. I said, "Oh, have you seen this stuff... it looks interesting." So we did it from that sort of base.*

Acknowledging the expertise of individuals and providing a mechanism for them to share their knowledge with colleagues builds the confidence of those involved as well as their commitment to the integration of computer-based learning. Additionally, this mechanism contributes to succession planning by nurturing and maintaining locally developed expertise and knowledge. One assistant principal described this situation in the following way:

> *I'm not going to be here forever...so, I hope that what happens here, when I leave, is that everything continues as if I still was here. There are a lot of schools that I've seen where one person does everything. And if they leave or they spit the dummy and the whole thing falls flat, the kids and staff are the ones that miss out. So, we're trying really hard to give everybody expertise and responsibility.*

It is also recognised within the literature that teachers generally need assistance (after the introductory training) to prepare them to use the technology in meeting their particular instructional goals. Opportunities to work with colleagues as mentors in a sustained way over a period of time, and provision of onsite support, increases teachers' use of computer-based learning (Becker, 1994; Collis and Carleer, 1992; Swetman and Baird, 1998; and, Greenberg, Raphael, Keller, and Tobias, 1998).

We recommend that schools be encouraged and supported to make provision for mentors and mentorees to work together on developing and co-teaching integrated curriculum ideas.

1.2.c. Teaching practices observed

We interviewed all the teachers that we observed to gain a deeper understanding of their classroom practices. Drawing upon the data we collected we identified two findings related to teaching practices. These are closely aligned and should be treated as an inter-related set rather than as separate findings.

Key finding 5: Teachers tend to implement CBL in ways that reflect their existing teaching strategies

Our observations suggest that teachers generally integrate computer-based technology into their existing teaching strategies. This observation was confirmed during our interviews with teachers as most stated that computer-based technology had *not* fundamentally changed the ways in which they teach or the ways they design learning experiences within the classroom. In other words, they were using technology as a replacement tool to provide tasks similar to those not mediated by technology.

Whilst we acknowledge that it is difficult to extrapolate our findings beyond the schools in our study, these findings are consistent with another recent Australian study which concluded: "the substance of learning and teaching remains more or less the same as it was in the 'pre-computer era', only now 'technologised' under a new technology regime, machines having replaced pens" (Lankshear, Snyder & Green, 2000, p.22).

A notable exception to this was found in a physical support unit. The severe physical disabilities faced by some of the children heighten the ability of technology to make a significant contribution to the children's independent learning processes. As one of the learning support teachers explained:

> *Any of these children that need to write to do anything can only use the computer because they have no hand functions. So for maths, they can't use their hands to count or actually manipulate objects so quite often it's all done on the computer.... Computers have opened up opportunities that they otherwise wouldn't have.*

We also observed a small number of teachers who were utilising technology in ways that transformed learning experiences. For example, we observed multimedia project work in a Year 6 class that illustrated open ended learning activities and higher order thinking; the use of email in Year 11 English to provide increased opportunities for discussion and shared understanding by keeping track of dialogue and maintaining an archive of discussion; and, a Year 7 literacy room built around interdisciplinary thematic units structured by team teaching and cooperative learning. In the literacy room, the students cycle through homework, reading and computer-based activities. They work in groups of about eight under the supervision of either a teacher or teacher's aide. The activities are interrelated. For example, the students might select a reading from a collection of texts, chosen by the teacher from the library or from popular texts such as newspapers, then after reading for 10-15 minutes they move to the computers where they write a daily reflection on what they have read. This is a critical reflection about what they enjoyed, disliked and learned. Additionally, the homework activity builds off the readings and develops their critical literacy and writing skills. According to their teacher:

> *Kids like computers but they don't like reading and they don't like writing, so what I've done is use computers to teach reading and writing. (Literacy Teacher)*

For the most part, teachers who were integrating transformative learning activities were recognised as good teachers generally. They tended to be confident early adopters of technology, they were prepared to take risks and respected by their colleagues as high quality educators. These teachers illustrated earlier research findings that identified a strong link between exemplary approaches to computer-based learning and constructivist approaches to teaching. Even so, Hannafin (1999) acknowledges that approaches to computer-based learning will not be widely implemented unless teachers' beliefs and expectancies about learning coincide with the pedagogical underpinnings upon which these approaches are based. Similarly, Means (1994) stated that teachers' views about learning must be

recognised as critical factors in curriculum reform and adoption of the technology that supports reform. As one Principal explains:

> *Because I'm beginning to use it more, I begin to see the extended possibilities. And it can be overwhelming but I've got to keep saying to my staff that the more you get into this the more your vision will expand.*

Our observations suggest that integrating CBL is integral to the broader, and ongoing, challenge faced by schools related to enhancing the quality of teaching and learning.

We recommend that the integration of CBL be embedded within a broader focus on quality teaching and learning that provides opportunities for teachers to reflect upon their approaches to teaching and the nature of learning.

We recommend that teachers with advanced pedagogical skills, who already competently use CBL to achieve existing curriculum goals, be targeted for enhanced professional development that supports their use of CBL and develops their capacity to mentor colleagues.

Key finding 6: **In a large proportion of the classrooms we visited, computer-based learning was being integrated in ways that afforded less opportunity for higher order thinking, deep knowledge and substantive conversation than classrooms where it was not being integrated. At the same time, these classrooms appeared to increase opportunities for making links to the world beyond the classroom.**

These findings are based upon a comparison of our structured observation of the level of *authentic pedagogy* (see section 2.1.a) in the classrooms in our study with the large scale Queensland School Reform Longitudinal Study[i] (see section 5.1 for further details). An example of what a classroom illustrating this finding might look like is provided by a Year 5 "ask an expert" activity. We observed small

groups of students devising lists of questions to email an expert in a particular field. This facilitated the students' contact with a source of knowledge beyond the classroom but the focus was on the technology rather than on access to expert knowledge. Hence, the questions tended to be superficial and perhaps could have been more appropriately answered by reference to readily available printed sources.

The comparison of our structured observations with the QSRLS is a preliminary attempt to begin to describe in more quantitative terms the impact of computer-based learning integration on teaching practices. The small number of observations and observers, combined with possible subsample effects, suggest that we treat these comparisons cautiously. Even so, they have been included here because of their potential contribution to future research directions and because they provide a different, albeit speculative, lens through which to view the qualitative data.

We recommend that future research monitor the effects of CBL on teaching practices and attempt to describe in greater detail how teachers' attempts to integrate CBT impact on their pedagogical repertoire.

1.3. Summary of recommendations

- We recommend that support be given to all schools to develop a Technology Vision Statement that reflects a shared vision for learning.
- We recommend that principals, and other leaders of learning, be supported to actively lead the integration of CBL in their schools.
- We recommend that the NSW DET put in place mechanisms to ensure that schools have access to technical support that facilitates their effective use of computers.

- We recommend that schools utilise whole school approaches to the integration of CBL which incorporate a range of strategies to actively involve the whole school community in the process of integration .

- We recommend that schools be encouraged and supported to make provision for mentors and mentorees to work together on developing and co-teaching integrated curriculum ideas.

- We recommend that future research monitor the effects of CBL on teaching practices and attempt to describe in greater detail how teachers' attempts to integrate CBT impact on their pedagogical repertoire.

- We recommend that the integration of CBL be embedded within a broader focus on quality teaching and learning that provides opportunities for teachers to reflect upon their approaches to teaching and the nature of learning.

- We recommend that teachers with advanced pedagogical skills, who already competently use CBL to achieve existing curriculum goals, be targeted for enhanced professional development that supports their use of CBL and develops their capacity to mentor colleagues.

- We recommend that future research monitor the effects of CBL on teaching practices and attempt to describe in greater detail how teachers' attempts to integrate CBT impact on their pedagogical repertoire.

1.4. Positioning this study within existing research

This research has similar characteristics to case studies reported in the CBL literature but even within this literature, there is great variation in scale and focus. Hadley and Sheingold (1993) classified case study research into two major areas of study:

- Small-scale case studies in a number of schools that focus on a particular pedagogical purpose, such as student inquiry or systems thinking;

- Case studies that have tracked practices and impacts resulting from classroom environments richly endowed with computers.

Whilst these studies have been informative, the first type does not easily yield implications for the broader picture. In addition, the second type does not tell us much about schools that have not had access to such resources. Due to scale and purpose, this study has not been able to address the general shortcomings of previous case study research in the area. Rather it has attempted to describe a broad range of factors related to the integration of CBL in different schools at different stages of integration.

The utilisation of a classroom observation instrument is an attempt to contribute to a systematic analysis of the impact of computer-based technology on teaching and learning. Kromhout and Butzin (1993) identify the need to develop appropriate tools to assess innovative programs as well as the need to analyse the impact of computer components on program effectiveness. Similarly Goodyer (1999), reporting on the proceedings of a workshop on *Information and Communication Technologies and the Curriculum*, highlighted the need to develop a framework for handling the impact of the new technologies.

Windschitl (1998) also takes up the importance of being able to describe and analyse how CBL impacts on learning in relation to the integration of Internet applications. His suggestions resonate with our stated emphasis on learning outcomes (see section 1). For example, he argues that there is a need to develop theories and methods to analyse web-supported inquiry. He recommends that more critical qualitative studies be conducted, which investigate learners' activities and teachers' roles in relation to the use of the World Wide Web (www). He suggests questions such as: Is the www helping students as an inquiry tool? Is it changing pedagogy? How do students share meaning? And, how are social constructs such as authority or co-operation affected? To this end, Windschitl (1998) suggests that researchers need to distinguish between using technology and using information, as well as between accessing information and having a learning experience. He argues for a stronger research focus on aspects of learning and teaching as influenced by the use of the www. He indicates that there is a

need for researchers to investigate the real changes occurring as a consequence of Internet teaching and learning.

Further support for the type of research we have undertaken comes from Selwyn (1997) who claims that to date there has been a concentration on large-scale surveys or small-scale case studies. He says that there is a need for contextualised qualitative and ethnographic research to analyse, rather than predict, what is actually happening and what type of relations people are developing toward technology. There is a great need for sociological and theoretical analyses that will focus on the social, cultural and historical constructs of computer-based technology and treat it as a practice rather than a machine.

Hadley and Sheingold (1993) suggest that:

> *What we need to understand, then, is the complex circumstances that surround the use and incorporation of technologies over many different examples, and how these are related to a variety of outcomes that are of interest. (p. 263)*

Like Moll (1997), we revoke some of the common assumptions and predictions made about the integration of technology in schools, namely, that technology is inherently good, cost effective and likely to improve the outcomes and processes of teaching. A number of authors have criticised this "techno-romantic" (Selwyn, 1997, p.305) view of educational technology, a view which is largely uncontested and partly responsible for infecting research in the field with excessive optimism.

Moll (1997) states that the need for integration of technology in the classroom is really tied to the greater plan of introducing information technology in society in general. Therefore, she suggests that a responsible plan to introduce technology in the classroom should firstly agree on a definition of education and its goals and second, be based on how technology will affect and restructure the learning environment and process rather than on how good a teaching tool it is. Through interviews with key stakeholders we attempted to gain some insight into how school communities conceptualised the process of integrating computer-based

technologies in schools. These interviews also focussed on critical issues and problems such as: the development of educational technology curriculum, identifying the working theories and concepts of the field, communicating the purpose and scope of educational technology to all parties involved, and determining perceptions and views of teachers within the field (Wicklein, 1993).

1.5. Structure of the report

The two major sections of this report are a review of the literature and a detailed description of the findings from the fieldwork. In two smaller sections we link teachers' approaches to integrating CBT to their views of learning and we provide an analysis of the processes that underpin related curriculum change.

The review of the literature was initiated through a preliminary search utilising ERIC that focussed on refereed papers describing school-based research. Two main search fields were combined: the first contained terms related to CBL such as "computer assisted instruction", "computer managed instruction", "computer uses in education"; the second contained terms related to school improvement such as "educational improvement" and "improvement". The literature that resulted from this process contains a number of hierarchies for describing the degree of CBL integration; it valorises constructivist approaches to CBL integration and emphasises the key role of the teacher in this process.

Data drawn from interviews with school-based educators and classroom observations forms the bulk of the *findings* section that is organised under the agreed outcomes of the research proposal, previously listed in section 1.1. Teachers' approaches to integrating CBL are described in section 5. This section has two major purposes: (1) to describe the classroom practices of teachers in the participating schools in terms of our chosen observation instrument; and (2) to interpret these practices through an examination of the models of learners' minds offered by Bruner (1996).

Finally, we analyse change processes related to the integration of CBT utilising Scott's (1999) theoretical framework. It identifies external context, leadership, milieu and learning programs as the four major elements of a change management framework for education. In section 6 we discuss our findings in relation to these elements.

2. Methodology

Data was collected during visits to six schools. We spent two consecutive days in each of four of these schools and one day in each of the remaining two schools. Information gathered during these visits included classroom observations that focused on teaching and learning processes, as well as structured interviews with key personnel, students, parents and other stakeholders. This report presents a detailed "snapshot" of how these schools approached the integration of computer-based learning during 2000.

2.1. Instruments utilised and developed for this study

2.1.a. Observation instrument

This study utilises a classroom observation instrument derived from the *Standards for Authentic Pedagogy: Instruction*, developed by Newman and Associates (1996, p.33) at the Centre on Organisation and Restructuring of Schools at the University of Wisconsin. Each standard is described on a five-point scale (see section 8.2). The observation instrument also includes another item related to describing the learning environment that was specifically developed for this study.

We have chosen an instrument based upon the *Standards of Authentic Pedagogy* because when compared to conventional instruction and conventional organisations, authentic instruction and "authentically" restructured schools have demonstrated overall greater rates of achievement, and more equitable achievement between equity groups (Newmann and Associates, 1996). Additionally these standards focus on the degree to which students are required to think, to develop in-depth understanding, and to apply academic learning to important, realistic problems. These are pedagogies that are identified in the literature review as supporting the effective integration of computer-based technologies (see section 3.2).

The four standards of authentic pedagogy instruction are:

Standard 1. Higher Order Thinking: Instruction involves students in manipulating information and ideas by synthesising, explaining, hypothesising, or arriving at conclusions that produce new meaning and understandings for them.

Standard 2. Deep Knowledge: Instruction addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understandings.

Standard 3. Substantive Conversation: Students engage in extended conversational exchanges with the teacher and/or their peers about subject matter in a way that builds an improved and shared understanding of ideas or topics.

Standard 4. Connections to the World Beyond the Classroom: Students make connections between substantive knowledge and either societal issues or personal experiences.

The additional standard developed for this study reflects the emphasis placed on contructivist approaches to CBL in the literature (see section 3.2). It describes the extent to which the learning environment is student-centred:

Standard 5. Student-centred learning environment: Students are an agent in the learning environment and take ownership to collaborate, explore, discover and create unique solutions to higher order learning problems.

2.1.b. Interview Schedules

The findings described in section 4 draw heavily upon two sets of interviews outlined below.

2.1.b.i. Teacher Interview Schedule

A Teacher Interview Schedule (see Appendix 8.1) was developed for this study. It was designed as a catalyst to facilitate conversation centred on lessons we had observed, the teachers' general approaches to teaching, their experiences related to integrating CBL and their understanding of a range of issues related to the integration of CBL in their respective schools.

2.1.b.ii. Interviews with other participants

A modified version of the Teacher Interview Schedule was used in the interviews with principals and other interested parties, including parents. Students were not interviewed in this study.

2.2. Participating schools

The six schools visited in this study were selected after consultation with a range of sources, including consultants and other researchers, who were of the opinion that these schools were making concerted efforts to integrate CBL. Additionally, to ensure that different types of schools were represented in the study, other indicators such as geographic location, school type and socio-economic status of the surrounding community were also taken into consideration. A number of the schools selected had previously participated in the *Computer-based Technologies Focus Schools Project*.

A brief summary of the schools, described using pseudonyms, is listed below:

- **Tall Timbers Primary School** is located in a major northwestern business area of Sydney and has 236 students. Contained within the school is the District Physical Support Unit. The students in this unit have a range of

physical disabilities and are integrated into the mainstream classes for part of each day. Under the principal's leadership, the school has embarked on a five-year technology plan and was currently in the second year of this plan during the research period. The initial stage has included professional development for the staff, students and school community facilitated through a mentoring program. The mentoring program was organised around the completion of a whole school CD-ROM, to which each staff member and student contributed with their newly acquired technology skills. The school is currently expanding its mentoring program and working towards a second whole school CD-ROM with the aim of further building skills, confidence and motivation.

- **Egan Avenue** is a Pre-school-6 primary school situated in the western suburbs of Sydney with an enrollment of 423 students. The school is in a low socio-economic area and is a PSFP (Priority Schools Funding Program) School. Egan Avenue was also part of the Focus Schools Program. The school has made CBL its focus since 1998 and has used mostly PSFP funds to finance this. Focusing on their priority of developing Microsoft Office applications, the school has in the last three years used external consultants to develop and lead staff through graded checklists focusing on such skills. In addition a computer lab has been established for students. All classes attend the lab weekly to work with the computer teacher through stage appropriate skills for Microsoft Office applications. The school is currently implementing a Technology in Human Society and Its Environment Program and plans to expand this program to other Key Learning Areas.

- **Garrison Central School** is a K-12 school on the northern tablelands of NSW. The school has a total of 252 students: 128 in primary school and 124 in high school. Approximately 30% of enrolled students identify as indigenous. The school is a PSFP school and was part of the Focus Schools Program. Over the last three years, an enthusiastic teacher, with the approval of the principal, has raised finances from various sources to

increase the amount of technology in the school. This has resulted in the establishment of a computer lab in the high school, as well as three computers within each primary class. Professional development of staff in the use of this technology has relied on staff members sharing their knowledge with each other on an ad-hoc basis. Although a technology vision for the school has not yet been articulated, the computer co-ordinator aims to continue to access as much finance as possible so that staff and students have available to them as wide a range as possible of the latest technology.

- **Coalfield Cliffs Primary School** has an enrollment of 379 students. The school is located in a recently established southern suburb of Sydney with a high proportion of young professional families. The school has been established for approximately 10 years. Since 1996 CBL has been used as one strategy in addressing the school's aim of enhancing teaching and learning and co-operative behaviour. Addressing this aim has involved the development of a learning process, used primarily for HSIE, which incorporates using the Hyperstudio Multimedia Package. A teacher- and student-mentoring program has been implemented in the school to develop skills in using the process. Two computer co-ordinators have acted in the role of teacher mentors. The computer co-ordinators left the school approximately 12 months before our visit and the principal now plans to "train up" two teachers to take on their roles so that the learning process can continue to evolve.

- **Amberdale Girls High School** is situated within the inner-west of Sydney. The school has 777 students and is located in a highly multicultural area of Sydney with many students who have English as a second language. Amberdale is a PSFP school and was part of the Focus Schools Program, 1999. The technology committee has developed a three-stage technology plan to be completed over a four-year period. With the completion of stage one, the number of computers has now increased and the networking of the school was nearly complete at the time of this

report. This stage has addressed their initial aim of doubling student access to computers. Over the next two years the focus of their plan is the professional development of staff and implementation of higher-level student research units for all Key Learning Areas (KLAs). This will be followed by a final stage of creating a whole school plan and developing student technology skills.

- **Newbridge High School** is located in an inner Sydney suburb. It is classified as a disadvantaged school and has just over 600 students most of who are from a non-English speaking background. Our visit to Newbridge focussed mainly on the Year 7 Literacy Room where technology is integrated across the curriculum. Team teaching is an important feature of this program that fulfills a secondary goal of facilitating opportunities for professional development.

3. Literature Review

The following section considers findings and recommendations from studies and conceptual analyses in the area of computer-based learning. As indicated in the Executive Summary, the major search fields utilised were those pertaining to CBL and those related to school improvement. These searches led to a literature review that considers the impact of CBL in the context of effective schooling. It should be noted that the literature review is not all-encompassing in either the fields of CBL or school improvement but focuses on those studies which were considered by the authors to be of value in informing the research questions we have asked in this study. Further, it should be noted that the field under investigation here is one that is seeing much change and what is written here is based on a literature search conducted in 2000.

Research in the field of CBL has focussed on four broad issues, namely: technical, pedagogical, economic and strategic (see for example Barker, 1999). Our review focuses on pedagogical issues. Aligned with this is a focus on the teacher as the critical variable because, as Collis (1996a) argues, effective teachers will utilise technology to enhance their learning designs whilst technology, alone, will not improve the effectiveness of other teachers.

As a consequence of this focus on learning and teaching, this review is divided into a number of sections. Section 3.1 reports on research into the integration of CBL. It lists different sets of criteria for analysing the degree of integration across a range of factors. Section 3.2 describes research studies that identify a pedagogical shift towards constructivism in effective integration of CBL. Section 3.3 describes research that sees the teacher as the key figure in the integration of CBL. Section 3.4 describes a range of other research findings related to the integration of CBL.

3.1. Integration research

In Western Australia, Treagust and Rennie (1993) evaluated approaches and programs implemented in six technology secondary schools. The effectiveness of the implementation process was evaluated in terms of:

(a) The intended curriculum, defined in terms of how technology was presented within written statements of policy, syllabus documents and teaching materials;

(b) The implemented curriculum, defined by the manner in which the schools incorporated technology into their programs; and

(c) The achieved curriculum, defined in terms of the degree of match between the intended and implemented curriculum.

Three major factors crucial for success of the school-based curriculum initiatives in technology education were identified: the need for continuous co-ordination, thorough documentation and time to accept ownership of the program, to plan modifications and implement changes, and for teachers to reflect on student outcomes.

Bortnick (1999) who identified criteria for developing a technology learning plan supports these findings in a later study. He recommends viewing technology as a tool for delivering quality programs and improving instruction to students. He suggests that,

> *Technology will not transform schools, rather schools must learn to harness technology to allow them to keep pace with the changes that impact their mission to adequately prepare students as productive citizens in a democratic, information-based society. (p. 1)*

Bortnick offers the following guidelines in designing and implementing computer-based technology in schools. The guidelines recommend that schools should:

- Improve communication and organisational efficiency;
- Implement networks that incorporate existing technology;
- Apply technology to improve curriculum development and instructional management;
- Expand the use of information resources in decision making;
- Focus and align technology initiatives with curricular goals; and
- Integrate with emerging technologies.

Wright (1994) states that it is essential for teachers and administrators to collaborate in developing and integrating effective technology education programs that encourage students to develop, produce, use and assess technology. Furthermore he suggests, along with others (Means, 1994; Dwyer, 1996; Saye, 1997; Davis, 1997; and Dockstader, 1999), that in order to integrate technology efficiently and make the best use of technology in classrooms, this collaboration should include reforming the curriculum. Tavalin and Gibson (2000) claim that for this to happen there is a need for a "consistent vision that forges a strong connection between technology training, curriculum integration, and student performance assessment" (p.42). Sherry, Lawyer-Brook and Black (1997) noted that "in schools where principals and technology resource people provided vision and support for technology, the use of technology flourished" (p. 231).

A number of studies have attempted to describe the degree of integration of computer-based technology in schools by delineating the sequence and scope of this process. Baker and O'Neil (2000), at the US National Center for Research on Evaluation, Standards, and Student Testing (CRESST), have proposed the following two hierarchies. The first relates to outcomes for students and the second to outcomes for teachers:

Hierarchy of Technology Outcomes for Students:

- Operating the hardware or the software intervention
- Achieving existing curriculum goals (more efficiently)
- Achieving new goals unattainable without technology, for example, inferences from seismic readings
- Achieving new goals unattainable and immeasurable without technology, for example, Web-search skills
- Developing technological literacy

Hierarchy of Technology Outcomes for Teachers:

- Operating the hardware or software intervention
- Increasing their subject matter knowledge and understanding by using appropriate systems
- Mapping technology tasks appropriately into instruction
- Differentiating technology instruction for students
- Providing expert assistance to students
- Critical understanding of desirable characteristics of technology-based interventions
- Helping other teachers
- Developing technological fluency

In relation to the integration of computer-based technology within the curriculum, Fogarty (1991) suggests that an interdisciplinary curriculum is of value, with thematic units structured by team teaching, co-operative learning, advisory groups, etc. He finds this helps students make valuable connections while learning to develop higher order thinking.

3.2. A pedagogical shift from "instructivist to constructivism"

Some studies suggest that the introduction of computer-based technology may facilitate a pedagogical transformation and promote a new educational vision. Barker (1999) claims that the integration of computer-based technology has the potential to produce an educational paradigm shift. He defines this shift as a move from instructivist to constructivism philosophies of teaching and learning; a move from teacher-centred control towards student-centred learning activities; a move from local to globally available resources; and an increased awareness of the importance of the use of computer mediation as a means of supporting knowledge transfer. Similarly, Saye (1997) finds that technology is perceived as a great simplifier. It enables efficient, enriched, empowered and controlled learning. Also, it allows a shift of knowledge construction from the teacher to the student and has the potential to reduce the dominance of text-based information transmission in favour of visual and multi-modal information.

Frequently, CBL is presented as enabling constructivist approaches to teaching and learning. A constructivist pedagogy is based on the belief that people actively construct knowledge and enter the classroom with specific goals, interests and understandings. Technology is seen as a great educational tool which could support teachers in presenting more complex tasks and material to students, in becoming facilitators rather than dispensers of knowledge and also in motivating students to attempt harder tasks (Hadley and Sheingold, 1993; Means, 1994; Dwyer, 1996; Sherry et al, 1997; Saye, 1997; Goodyer, 1999). Hill and Smith's (1998) study also shows that technology education programs based in community-projects, enhanced learning, by enabling a student-centred and constructed learning.

Hannafin (1999) states that innovative technology integration projects stress higher-order thinking skills and collaborative learning environments that are usually consistent with constructivist approaches. Such approaches advocate an environment where students and teachers learn and share knowledge. They promote student-centred learning or intentional learning with the student as an

agent in the classroom environment. The emphasis is on learning higher order thinking and collaborative problem solving strategies using open-ended or generative (creative and productive) instructional programs rather than on assimilation of facts (Cadiero-Kaplan, 1999; Hannafin, 1999).

Kneidek's (1996) case study on the use of technology in Hellgate School supports Hannafin's views. He found that the use of technology in classrooms engages students' interest to help them explore and develop their self-learning skills. This also frees teachers to individualise their teaching. The school has an integrated curriculum and a philosophy of hands-on and computer assisted learning.

Similar effects are associated with networking, Internet and intranet functionalities. Barker's study (1999) advocates the use of intranet, "a private in-house web-based network resource" (p.4), as offering the potential to enhance the quality of students' learning activities. He sees the intranet as potentially beneficial in accessing and delivering educational resources as well as facilitating new ways of supporting student-managed, autonomous learning activities. Barker finds that "electronic course delivery' (ECD), defined as "an integrated and holistic approach to course provision that depends entirely upon the use of teaching and learning resources that are made available in digital form" (p.4), offers greater flexibility in terms of learning and teaching techniques and mechanisms. Also he finds ECD provides greater access to resources as well as greatly improving the quality of students' learning experiences. He suggests though that ECD raises a few concerns such as the augmentation of lectures, determining the amount of face-to-face contact required, how to monitor and evaluate the process, including the cost effective use of hypermedia and the use of new technologies to support collaborative learning at a distance.

Also, Blumenfeld, Marx, Soloway and Krajcik's study (1996) found that email and online discussion groups increased opportunities for conversations and the creation of shared understanding among students as they kept track of dialogue and maintained an archive of conversations. The study also notes that students who do not typically participate in classroom discussion are more likely to

participate in online discussions. The questions that arise however concern instructions, availability of resources and adequate software.

Conversely, integration of CBL in ways that demonstrate constructivist pedagogy are dependent on teachers' beliefs in the value of such pedagogy. In her comparison of traditional and constructivist classrooms, Cadiero-Kaplan (1999) claims that,

> *integrating technology to encourage learners to construct, evaluate, manipulate, and present their ideas while demonstrating understanding of curriculum concepts and innovative constructs, is contingent upon the pedagogy of constructivism (p. 15).*

Furthermore, Berg, Benz, Lasley, and Raisch (1997) found that exemplary technology-using teachers are using technology in their classrooms in ways that are overwhelmingly constructivist. In these classrooms, CBL is mainly used for research, writing and desktop publishing. Technology is treated as a tool for exploring new information and producing new products. Students are actively engaged in learning: processing, transforming and producing knowledge. As Dwyer (1996, p.19) asserts:

> *Technology becomes a more general-purpose tool, allowing access to information, communication with experts, more possibilities for collaboration, and a creative medium for thought and expression.*

Starr (1996) looks at the potential of new technologies as educational tools and claims that the introduction of CBL is linked to eight shifts in education which are moving towards progressivism. These eight shifts include: a shift away from whole class to small group instruction, a shift from the teacher leading to facilitating activities and students and a shift from teaching students to students taking a central role in their own learning. However, he too suggests that technology alone does not determine these effects. He links these shifts to a post-industrial form of education or constructivist approach. In principle, he sees many benefits to using technology in the classroom: enabling two-way communication,

a powerful instrument of research, enhancing collaborative and interactive learning, enabling distance learning, helping create modest-sized schools and fighting inequality by improving everyone's access to information.

Similarly, Fiske (1998) sees the integration of CBL in schools in the US linked to the shift in values from standardisation to diversity. The new paradigm recognises the unsuccessful approach of factory-model schooling and looks to schools to equip students with problem-solving skills, improve academic performance (competitiveness and students' learning capacity) and promote choice and diversity (including learning styles) in schools. In this environment, computers are no longer only linked to 'trade' or 'technical' subjects but have a more central position within the curriculum (Treagust and Rennie, 1993). Technologies can then be used to play the roles of model learners or serve as valuable tools and allies enabling access to rich sources of data that allow modeling, open-ended learning activities and higher order thinking as well as providing lifelong learning skills (constructivist approach). In short, according to Fiske (1998), "the educational vision and computers that are driving the new paradigms are inherently interactive and dialectical" (p.13).

However, the progress of constructivism in the classroom and hence the adoption of constructivist pedagogies in CBL could be limited, or frustrated, by a well established resistance to educational change based on the level of uncertainty in the classroom tolerated by teachers and students alike (Saye, 1997). Hannafin (1999) acknowledges that despite the potential of projects such as those described above, they will never be widely implemented unless beliefs and expectancies about learning and tasks involved within the school culture coincide with the pedagogical underpinnings upon which these projects are based. He examined the attitudes, beliefs and expectancies about the school environment of 12 teachers in a middle-class public school in the US. His attempt to shift the attitudes of those teachers toward a more constructivist bias through their participation in three graduate technology programs showed that the task of changing teachers' attitudes about the school learning environment may be more difficult than researchers and educational reformers presumed.

3.3. The teacher as a key figure in the integration of CBL

A number of studies have identified the teacher as the key factor in CBL integration in classrooms and in its uptake by students. Authors have found that good integration of technology in the classroom is a slow process to which the key is the teacher's commitment, proficiency in using the technology itself and good teaching (Gerber, Semmel and Semmel, 1989; Tobin, 1992; Kromhout and Butzin, 1993; Hadley and Sheingold, 1993; Marcinkiewicz, 1993-94; Means, 1994; Means and Olson, 1994; Swetman and Baird, 1998; Thomas, Carswell, Price, and Petre, 1998; Yelland, 1999; ETS, 1999; Tavalin and Gibson, 2000).

Gerber, Semmel and Semmel (1989) found that teachers integrated technology in ways consistent with their concerns for classroom management, rather than to meet instructional objectives. In contrast, in a nation wide survey of more than 600 teachers, Hadley and Sheingold (1993) concluded that most of the teachers surveyed were "incorporating technology into their practice and classrooms in ways that deeply affect what they do and what their students experience" (p. 262). They found that on average these teachers' computers were used as multipurpose tools, which varied in relation to the grades and curricula taught as well as teachers' experience in the use of computers and applications. They also found that the most productive and versatile applications of CBL did not require the most advanced technology. Perhaps as Saye (1997) suggests progressive teachers are members of a minority culture with different beliefs about learning, technology use, and different dispositions for risk. However the importance of the context in which teachers work should not be overlooked as Becker's (2000) survey reminds us that US teachers with computers in their classrooms are more likely to use them than teachers who have access to computer labs.

Tavalin and Gibson (2000) looked at the stages of learning teachers go through as they develop expertise with the Internet. They found four distinct stages: 1) learners; 2) adopters; 3) co-learners/co-explorers with their students in the classroom; and 4) reaffirmation/rejection decision. Those who decided to adopt the Internet sometimes go on to a 5th stage of leader or exponent of the

technology, where they get involved in on-site workshops and peer coaching/mentoring and consulting.

Regardless of the focus or scope of the initiative, Collis (1996b) states that:

> *One type of result that consistently occurs is a result that acknowledges the teacher as the key figure in the eventual success or lack of success of any computer-in-education initiative (p. 21)...A good teacher may do very good things with networking opportunities; a weak teacher will not, no matter how we try with strategies and inservice training (p. 29).*

She found that the likelihood of technology being taken up by teachers relies on the expected payoff, the level of problems that have to be overcome and the pleasure of being involved in the innovation. Collis suggests that a successful integration of CBL should start with teacher's classroom problems rather than with technology or its promise. Further recommendations for school administrators and facilitators to support the take-up of technology integration by teachers include: anticipating the need to demonstrate some sort of meaningful effectiveness fairly quickly; making the use of the Internet and access to the www as easy as possible for teachers in the classroom; considering not putting the computers only in a computer room; considering the idea of portable computers; and supporting the enthusiasts.

Marcinkiewicz (1993-94) focused on teachers' use of computers and found that teachers were largely under-utilising the computers available in their schools. The purpose of his study was to explore whether, and if so what, personal variables influenced teachers' computer use. He examined the predictiveness of several personal variables of 170 elementary school teachers to their use of available computers for teaching. He found that the three main external influences in the use of educational computing were related to the level of support, the resources available and teachers' satisfaction. Using logistic regression analysis Marcinkiewicz identified self-competence and innovativeness (one's willingness to change) as the personal variables most closely related to teacher's computer use.

Greenberg, Raphael, Keller, and Tobias (1998) conducted an in-depth case study of teachers' use of image processing in science classes in one US high school. Data sources included interviews, classroom observations, demographic data and documentation of district- and school-level support. One key finding of this study was that after the introductory training, teachers lacked assistance in preparing them for using technology to meet their particular instructional goals. Teachers greatly increased their use of CBL when they had a student teacher or adult team-leader working with them. This is further confirmed by Becker's (1994) survey of 516 computer-using teachers of English, Math, Science and Elementary from 3rd to 12th grade in 1989 in the US. He found that access to computers and training was the most influential element in developing exemplary computer using teachers (teachers who frequently use computers for activities that involve higher order thinking). He also suggested that exemplary computer-using teachers had changed the content coverage of the curriculum, dropping the weaker and outdated elements.

Teachers must be given time, training and support to integrate computers in their curriculum. They need professional development but more importantly onsite support and mentorship/individual assistance (Collis and Carleer, 1992). Swetman and Baird (1998) found that "teachers increase their use of computers when they are provided with sustained support over three or four years". These were the results of a case study of a four-year program designed to increase mathematics and science teachers' use and comfort-level with computers in the classroom. Findings acknowledged that required beneficial support included: access to mentors and peers, access to hardware and software and time away from teaching duties.

Becker (1994) supports this finding. He finds that to be an exemplary computer-using teacher one must have access to other adults from whom one can learn. He concludes that exemplary computer-using teachers are directly related to the total number of computer-using teachers as well as the support and training of staff provided in schools, rather than to being a competent computer user. Furthermore, resource-rich environments (smaller classes, more hardware and software, etc.)

coupled with further education and an interest in effective teaching and learning are more conducive to developing exemplary computer-using teachers as they provide a better opportunity for practice and formal training.

Teachers' views about learning, constructivist or not, must be recognised as critical factors in curriculum reform and adoption of the technology that supports reform (Means, 1994). In other words, there must be some resonance between teachers' views about learning and the pedagogical underpinnings of the technology integration projects they are implementing (Tobin, 1992).

In a local study, Downes and Fatouros (1995) analysed classroom stories of integration of CBL in the Sydney area. They found that CBL changed teachers' concepts of literacy. It pressed teachers to go further than simply use computers to support their practice. It challenged teachers to emphasise talking, listening and include images as a distinct mode of communication.

Other examples of research which focussed on the teacher as the key figure in the integration of CBL, include:

- Saye's (1997) two-year long survey of technological innovation based on nine students. He found that the integration of technology was related to students' and teachers' perceived role of schooling: a tool controlled by the teacher to facilitate delivery of content or as a tool to enhance students' own learning.

- Braun's (1997) claim that unless students are prepared by teachers to be critical in evaluating the information downloaded from the www they run the risk of being manipulated or persuaded to accept misleading or false information.

- Mean's (1994) finding that the use of technology increases teachers' sense of professionalism and achievement and a sense of being a part of a professional community (Fiske, 1998).

3.4. Other related research

Recent research on learning has considered the concept of "social learning". Salomon and Perkins (1998) identify six distinctive meanings of social learning. The first four are of most interest in this study. Salomon and Perkins summarise the four as follows:

> *The first, social mediation by an active agent (social mediation for short), reflects a range of major figures and lines of inquiry in such areas as cognitive development, tutoring, peer tutoring, collaborative, cooperative and reciprocal learning, and more. The second treats a major stream of contemporary thinking that emphasises participatory learning and "distributed, situated cognition." The third deals with the mediating role that tools and cultural artifacts, embodying accumulated social wisdom, play in the process of learning. And the fourth reflects a tide of interest in team and organisational learning, sustained by practical interests in the worlds of business, government, and sports, and by the inquiries of psychologists, sociologists, and anthropologists into the workings of collectives of various kinds and sizes (p. 6).*

Of major relevance to this study on CBL is the third type of social learning, "social mediation by cultural artifacts" (Salomon & Perkins, 1998, p.10). In analysing the role of tools in learning, the authors suggest that the use of computers in schools carries with it a whole educational philosophy of how knowledge is constructed, and of how learning experiences should be designed, and implemented. The authors argue that although computers are often used as alternative tools for traditional classroom teaching, they have the capability of being subversive instruments which promote the restructuring, both of classroom learning environments, and of teachers' ways of teaching, assessing and defining curricula (p. 12). This suggestion is supported to a large extent by the studies reported below:

- Liu, Macmillan and Timmons (1998) carried out a comparative analysis of computer assisted learning versus learning without computers integrated in

the curriculum to assess the effects of computer integration on students in terms of academic achievement and attitudes toward academic subjects and computers. The research, based in Canada, was non-conclusive. The quantitative results showed that there was no significant difference in achievement or attitude between the computer assisted and the non-computer assisted learning students. Yet, the qualitative data indicated that generally students perceived computer integration as having a positive effect on their learning.

- Cuban (1998) carried out a cross-institutional comparison of Stanford University professors and public school teachers in the US. His study aimed at examining why, despite a wealth of resources (access to hardware, software, technical assistance and professional development), the use of new technologies in the classroom by professors is as limited and unimaginative as that of public school teachers who lack these resources. He concluded that the problem is not one of "low-tech teaching" but one of a "struggle over core values" (p.7). Teachers find the use of computers in the classroom interferes with their authority and the nature of teaching, which they define as building social relationships with students and helping students learn about democracy rather than preparing students for the technological workplace. A further drawback described by Cuban is the constant change in hardware and the lack of tailored software. These conclusions are criticised by Dede (1998) and Garofalo (1998) as naïve views of educational technology. Furthermore, Willis (1998) finds Cuban's analysis dated. He also finds that his critical perspective is narrow-minded as it assumes that technology in education can only be used from a behavioural paradigm.

- Collis and Carleer's study (1992) described ideas and experiences about "Technology-Enriched Schools" (TES). The nine TES case studies described provide a rich description of schools attempting to reduce the problems and constraints associated with integrating CBL in schools. The case study schools are located in North America, Europe, the UK and the

> Middle East. Collis and Carleer state that these projects are based on educational needs and vision, not on technology: "They are focussed on the restructuring of education, with technology as a partner tool" (p. 3). Their study found two distinctive uses of software. Firstly, as a creative and productive tool and as an instructional software with a specific curriculum focus. Their study also found that the majority of projects had dedicated rooms as computer laboratories and used a broad range of educational technologies. They concluded that restructuring of education in the TES did not occur.

Finally, the issue of cost-effectiveness on a broad and sustainable scale is commonly predicted but proves to be difficult to document. The cost-effectiveness rationale is mainly based on the assumption that the cost of technology will keep on going down hence technology will be able to replace teachers and be cost effective to schools. Thomas et al (1998) evaluated the use of the Internet in distance learning with the Open University. From their results they conclude that the use of the Internet in a holistic manner is successful in delivering the courses and very cost-effective since it reduces processing time and administration costs. Similarly Starr (1996) sees computer communication making contacts between school and society easier and less costly. Also, he suggests that, in a near future with the cost of computers reducing, computers will allow for individualised instruction, smaller classes and smaller schools.

Dede (1998) argues however, that information technology is a cost-effective investment only in the context of systemic reform. Dede offers advice in relation to CBL. This includes remembering that hardware and software technologies are just one part of the infrastructure needed for schools, that training is essential to use it to its full potential and that ongoing maintenance is required to keep the technology current and operational – "else classroom computers that are acquired as panaceas end up as doorstops" (Dede, 1998). He suggests that to be affordable and sustainable computer-based technologies should look outside the classroom at technologies already available in homes and workplaces. Improvement in educational outcomes will only occur when simultaneous innovations in

pedagogy, curriculum, assessment and school organisation are coupled with usage of CBL.

4. Findings

Having presented an overview of the study and our research methodology in Chapter 2 and positioned our study within the research literature in Chapter 3, we now proceed to present and discuss our findings.

The findings reported here are based on multi-level data collected from the six case study schools that includes interviews, classroom observations and school documents. The anticipated outcomes of this study have been used to structure the organisation of this section. Hence, the findings are reported under the following headings:

- Identification of key issues faced by a range of government schools at different stages of their development in integrating computer-based technologies across the curriculum (see 4.1);
- Documentation of a range of strategies adopted by different types of government schools in integrating computer-based technologies across the curriculum (see 4.2);
- Synthesis of the views of key stakeholders involved in the integration of computer-based technologies across the curriculum (see 4.3);

4.1. Key issues faced by a range of government schools at different stages of development in integrating computer-based technologies across the curriculum

Each case study school had adopted a different approach to integrating CBT into planning, the curriculum and classroom teaching. We have chosen a number of specific examples to discuss in this section that will illustrate the varying effects of these different approaches and their contexts.

The key issues discussed in this section are:

- The importance of the school's Technology Vision Statement (see section 4.1.a);
- The importance of involved leadership and succession planning (see section 4.1.b);
- The need for technical support (see section 4.1.c);

4.1.a. The importance of the school's Technology Vision Statement

The importance of consistent vision that articulates the integration of CBL with other elements of the curriculum has been confirmed by previous studies (see for example Wright, 1994 and Tavalin & Gibson, 2000). We observed a number of schools where a consistent vision had been established as a result of the development of a Technology Vision Statement. One principal described the situation prior to the development of their statement as, "very haphazard, depending on the teachers' capabilities and interests". The Technology Vision Statements detailed plans for achieving various educational objectives such as empowering students in their use of technology, enhancing learning through technology and enhancing administrative procedures.

In schools where these statements had been developed we noted the executive more able to articulate a clear vision for technology integration:

> *The vision for computer-based learning within the school is that children understand that it is just part of normal work and normal life. (Principal)*
>
> *The ultimate goal is to get everyone using it as a tool rather than as an add-on. (Computer coordinator)*
>
> *A part of the "vision was to empower staff to become lifelong learners ... especially in technology where it's changing so rapidly ... and to have all staff and students using technology. (Principal)*

Schools approached the development of their vision statements, or plans, in varying ways. For example;

a) Amberdale GHS has had a technology plan in place for a number of years prior to our visit. They developed this plan by identifying key issues that needed to be addressed for successful integration of technology within their school. These issues included budget, upgrading of equipment, teaching and learning and information skills. Utilising a collaborative process, these issues were prioritised and incorporated into the school's technology plan that was to be implemented in three phases over three to four years. Phase one was almost complete when we were visiting the school in the first half of 2000, phase two was just beginning, and phase three was still in planning stages.

1) The first stage of the school's Technology Plan was the "Technical" stage, which focused on the establishment of appropriate hardware. As the school is in a low socio-economic area, the staff's priority was to increase student access to computers at school by increasing the number of computers and the computer space provided. Since embarking on their technology plan in 1997, student access to computers has doubled and networking of the school nearly complete. There is also at least one computer in each of the staff rooms and more money has been budgeted for upgrading and/or increasing the quantity of staff room computers. Staff interviewed felt that more printers were still needed.

2) The second stage of the school's plan focuses on staff development. The deputy principal describes this stage as focusing on two areas: "training teachers and implementing, in classrooms, higher level research units". The aim is that teachers will be trained in both awareness of, and skills in, information technology. In addition higher-level research units will be implemented over a two-year period, beginning this year. Initially, a few faculties will use computers to conduct higher-level research activities with their classes, and then serve as "lighthouse faculties" for the others.

3) The third stage will focus on "skilling" the students, beginning with the students in years 7 and 8. The aim of this stage will be to use technology in an integrated way with the students so that their skills and knowledge can be built on in future years. The third stage is seen as "A whole school plan to teach information technologies to students in a deliberate way and that would involve things running through the library and every other faculty" (Deputy Principal).

b) At Tall Timbers PS, data collected by the school community (staff, students and parents) in 1998 suggested the need to develop a plan to integrate technology into learning and teaching. The school community worked collaboratively, drawing on expertise of the District Office and others within their local and international IT community to develop a five-year plan. The District Technology Advisor played a key role in providing departmental knowledge, policy and planning advice as well as links with other school projects and trials. Parents with specialist educational and technology expertise also assisted in the development of the school's strategic management plan, as did discussions with a principal of a North American school.

The plan encompassed a vision statement, broad goals and specific strategies. The first stage of the plan, completed at the end of 1999, culminated in the development of a whole school CD-ROM and a series of web-based resources created by the students. Specific strategies elaborated on at the outset and the evaluation of them is guiding development in 2000 and subsequent years.

In his interview, the principal expanded upon this vision for integration of technology into teaching. His aim is for CBL to be "invisible, seamless and embedded" within learning programs for students and teachers. He described the question guiding the integration of technology into teaching as "How do we use the computer to enhance our learning?" rather than "How do we use computers?"

Some of the goals identified by the school community to enhance learning included providing:

- All students access information technology to enhance learning and teaching outcomes across the Key Learning Areas.
- Students, staff and parents use computer-based technologies to locate, evaluate, access, manipulate, create, explore, store and retrieve information across the Key Learning areas.
- Teachers, parents, students, administration staff and teachers' aides will continue to grow professionally through training and development in Information Technology.
- Links will be established with the local and international IT community

These two examples demonstrate how the creation of a Technology Vision Statement can provide a vehicle where local broad-based collaborations can focus on how to use technology to enhance learning. From our observations, it would appear that the process of generating a Technology Vision Statement has the potential to make a significant contribution to the development of a shared vision for learning which appears be an essential element of successful CBL integration

To emphasise the need for a strong coherent vision statement that is linked to learning we recommend that all schools develop a Technology Vision Statement that contains a shared vision for learning.

4.1.b. The importance of involved leadership and succession planning

Previous studies have highlighted the importance of leadership in supporting the process of CBL integration: Treagust and Rennie (1993) pointed to the need for continuous coordination and Sherry, Lawyer-Brook and Black (1997) focused on the importance of vision and support for technology. In our study, we observed different forms of leadership that contributed to the schools' integration of CBL. In this section we describe leadership exercised through executive staff, committees, and enthusiastic teachers. Our observations lend weight to the general

consensus in the literature that, whatever its form, leadership is an essential element of the integration process.

4.1.b.i. The principal

At Tall Timbers PS, strong coherent leadership was an important factor in initiating and maintaining the impetus for integrating CBL. The principal strongly advocated the infusion of technology into classroom practices. His core understanding was that pedagogy should be placed before technology because in this way the learning of children will be enhanced. In his interview with UTS researchers, he stated:

> *We're coming from a pedagogical base, not a box and cable base, so we're always looking at our teaching practices and how the box can enhance the teaching practice or the learning.. as opposed to many of my colleagues who talk about the necessity to get their school cabled and get boxes in rooms, I say: "to what end?" "Oh so that kids can get on the web." And to what purpose? I think unless you're being driven by pedagogical approach, it's too easy to let the technology dazzle you. And people talk about all our technology's being finished, because we've got a machine in each room and we're cabled.*

Successful integration of CBL is tightly coupled to the school's vision for learning, therefore it is the principal, and other leaders of learning in the school who should lead this reform. Whilst schools which do not have their principal actively involved in CBL integration are still capable of making progress, the involvement of principals intent on improving learning through CBL has the potential to strengthen and align their schools' efforts.

We want to emphasise the key role played by principals in integrating CBL by recommending that principals be supported to actively lead the integration of CBL in their schools..

4.1.b.ii. The committee

At Amberdale the Deputy Principal worked with the Technology Curriculum Coordinator and a technology committee to develop the school's Technology Vision. According to the Deputy Principal, the school's vision for technology usage emerged from the work of the committee:

> *It's emerged organically really out of a technology committee that's been very broad based here for a long time.*

The technology committee has provided ongoing, stable and enthusiastic leadership for the development of the school's vision for technology usage. It has put in place measures for professional development, time release and support. Regular attendees at technology committee meetings are the convenors, the network administrator and a teacher who acts in a mentoring capacity for technology. Committee members stem from various faculties within the school. All teachers are welcome to attend and some attend sporadically.

4.1.b.iii. The motivator

At Garrison Central School, we encountered one individual who initiated a "bottom-up" approach to change. This motivated computer enthusiast, with the approval of the executive, initiated and developed the use of technology within the learning environment of the school. This teacher has encouraged staff to develop their technology skills, acquire resources and make decisions regarding the area of technology within the school.

> *I see my role as to tell the staff about what is happening in the school regarding technology. Well, I tell a bit more actually. I enthuse them about something I see on the horizon that the school might be chosen for. We've had our hands up for everything that comes past. We've been chosen a few times and I think success breeds success and positiveness breeds positiveness.*

This teacher's enthusiasm has played a major role in developing staff interest and skills in using technology in the learning environment. He takes every possible opportunity to share ideas and skills. As he suggests,

> *I just keep niggling away at them (the staff). I give lots of enthusiasm and lots of positive reinforcement.*

At Coalfield Cliffs PS we observed the impact on integration at the departure of a "motivator". The school's key resource teacher who had been the driving force behind the original technology committee, and who had coordinated the school's technology integration, had left the school approximately 18 months before our visit. The school continued in their integration of CBL, however, it was noted by the principal and teachers that with this teacher gone, the process of integration had ceased evolving and adapting to the school's needs. The principal noted he was trying to "skill up" two new teachers to fill the role. From his perspective the issue was not one of motivation but skill as the remainder of the staff had limited expertise in this area. This issue arose in a school which is characterised by a stabie staff however, such an issue is likely to be even more significant for schools with high staff turnover and /or small staff numbers.

4.1.b.iv. Succession planning

A key factor in maintaining stable leadership in relation to CBL is the need for succession planning. This is highlighted by the departure of key change agents and the need to maintain momentum beyond the early stages of integration that are often led by enthusiastic and committed staff. Members of the executive at Tall Timbers PS stated that they had recognised the importance of succession planning since the very early stages of CBL integration when they had formed a technology committee to ensure that the development of IT strategies was not left in the hands of an individual.

> *And they've moved steadily with key players coming in and out of that. Key players who've moved onto other schools for example. They had a clear vision when I came at the beginning of 97 ...[that] what we call the*

hardware planning was simply stage 1. We've always had professional development here in technology. That was quite seriously understood and accepted by all members of staff. (Deputy Principal)

At Tall Timbers, provision was made for the continuation of CBL though the preparation of experts to act as mentors. Both the principal and assistant principal recognised that the mentor training program addressed the possibility of burn out of the key leadership personnel as well as ensuring that the CBL initiative would continue should key resource people leave the school. The identification of this need to plan for the continuation of the program reflects an issue that this school had identified early in the process of CBL integration- that it is important to maintain the sense of community and purpose that underpinned the planning for infusion of technology into learning and teaching.

The assistant principal strongly held the view that a technology plan cannot succeed in the long term if it is reliant on one person only. The plan for this school, which was developed collegially through community members, had an emphasis on training experts as mentors and reflects this philosophy. She stated:

I'm not going to be here forever. And everybody knows that. I love it here. But I won't stay here forever. I'm not that sort of person. I need a new challenge in three or four year's time. So, I hope that what happens here, when I leave, is that everything continues as if I still was here. There are a lot of schools that I've seen where one person does everything. And if they leave or they spit the dummy and the whole thing falls flat, the kids and staff are the ones that miss out. So, we're trying really hard to give everybody expertise and responsibility.

The importance of stable leadership in CBL integration has led us to recommend that teachers with advanced pedagogical skills, who already competently use CBL to achieve existing curriculum goals, be targeted for enhanced professional development that supports their use of CBL and develops their capacity to mentor colleagues

4.1.c. The need for technical support

While the focus of this study was on how technology is being integrated into learning programs, we were continually alerted to the need for computers to be well maintained and for teachers to have access to technical support. The schools we visited had developed a variety of coping mechanisms that reflected their local conditions. The mechanisms that were most successful were able to respond quickly when problems arose and were available on a regular basis providing teachers with a sense of reassurance knowing that their technical problems would be attended to quickly. This enabled them to concentrate on learning programs and seemed to instill a sense of confidence that generated a positive attitude towards integrating technology.

Garrison CS had two technicians who maintained the computers within the school. These technicians were from the local community and volunteered their time and expertise to maintain the computers in the school. The staff highly valued the work of these volunteers and attributed much of the school's ability to integrate CBL to their support. Even so they also acknowledged the need to "upskill" themselves,

> *Because the technician isn't always available you have to learn how to get around common minor problems.*

This need was also recognised by teachers in other schools. As one of the teachers related when asked if there were any problems with using the computers in teaching:

> *[There's] a constant maintenance problem because things go wrong - just bits and pieces. But you have to be able to resolve those problems yourself. You've really got to become adept at sort of understanding your own computers. And you tend to if you have them long enough.*

It was not uncommon for schools to contract private companies to address technical faults in computers and the school network. For example, at Egan Avenue PS, a technician was paid to visit the school once a week to fix hardware

and network problems. The importance of computers that work and of being able to fix them quickly when they break down is a high priority for teachers because it enables them to focus on learning issues rather than technology problems. Negativity concerning the integration of CBL appeared to set in quickly when maintenance problems were not attended to promptly.

An innovative approach to the issue of technical support was in operation at Amberdale GHS where ex-students were employed as technology assistants. Ex-students studying computer science at university or those recognised as competent users of technology are employed on a casual basis to help maintain hardware and work on the school's website. This strategy has also provided students at the school with positive role models:

> *And the really good thing about that is that first of all the girls who are still here see a couple of students, who've gone on to do computers at university, are coming back into the school, talking to them about how good it is. They are providing a really positive sort of technology feedback and the fact that these girls ... you know they were only here at school, in one case only one year ago, and they're going around fixing the computers which is really good. (Librarian)*

At Egan Avenue PS, Garrison CS, Amberdale GHS and Newbridge HS, many of the initiatives were supported by PSFP funds. Alternatively, at Tall Timbers PS financial strategies include the use of professional development funding for staff release and training support. As the principal stated,

> *We put our money where our mouth was. We diverted money to support training. If staff needed to be together then we used training development money to release staff to look at how that they could work together.*

It would be outside the scope of our observations to make recommendations about how computers should be effectively and economically maintained in schools. However it is clear from our observations that functioning computers and "fast fixes" when they break down are essential to effective CBL integration. Therefore we recommend that the NSW DET put in place mechanisms to ensure that schools have access to technical support that facilitates their effective use of computers.

4.2. Documentation of a range of strategies adopted by different types of government schools in integrating computer-based technologies across the curriculum

The overall focus of this section is how schools have responded to the professional development needs of teachers integrating CBL in their classrooms. Particular attention is paid to a whole school approach because of how it supports and lives out the schools' visions for technology and because of the multiple positive effects that we observed; most significant of which is the way it benefits the whole school rather than token individuals benefiting from short external courses.

The participating schools adopted a range of strategies to integrate CBL across the curriculum. Here we discuss two whole-school strategies that appeared to offer innovative approaches to uniting a whole school community in its effort to effect significant change in CBL integration practice. The strategies documented in this section are:

- Getting started with a whole school project (see section 4.2.a)
- Collegial approaches to professional development (see section 4.2.b)

4.2.a. Getting started with a whole school project

Two of the six schools in our study utilised a whole school project to support the integration of CBL. The principal of Tall Timbers PS described this as "a hands-joined approach".

> *We all went to the side of the cliff, held hands and jumped...but I had confidence that the staff would (float). There's enough trailblazers to give us buoyancy and linking the hands really made people more buoyant.*

The assistant principal also recognised the importance of the involvement of the whole school in the planning:

> *It's that school-wide commitment and that's rare. I think that's why what we did worked out. ... I don't think that what we've done here would easily translate to a lot of other schools without that collegiality, that one-in, all-in sort of thing. It is very important, even more so than the quality of their training and the time involved.*

Both the principal and assistant principal at Tall Timbers agree that they do not expect everyone to progress at the same rate. The principal stated that he is quite comfortable with staff moving at different rates and consolidating on new learning achieved last year. As he says:

> *This year as a thematic unit we're going to look at the environment... They've stepped one step out and they've jumped...And now they're looking at how much can I jump again. They're some that are prepared to consolidate. And this year I want this theme to be consolidatory as well as developmental, so I'm comfortable with some remaining where they were last year. But some have already said: Well boy, you know, I did that last year, I want to - now linkages, you know, and do this and do that.*

Similarly Amberdale GHS developed a web page as part of the Focus Schools Project. This web page was used in the context of a literacy project aimed at developing the writing skills of students from both Amberdale and a feeder primary school. The project was beneficial as the skills in literacy would be more easily transferred from the primary to high school setting, and, in addition, the continuity of programs in both literacy and technology would exist.

The development of the web page was then expanded to include all faculties:

> *The website has been critical to get a mass of people involved and skilled in the technologies. The skilling of the people though, has been more important than the website...The website ignores what might be the PR aspect of schooling and is focused on using certain skills and certain texts for literacy and incorporating that and building on that for work in classrooms. (Deputy Principal)*

During this stage, two to three people from each faculty were encouraged to provide input on their learning area for the web page. It should be noted that those teachers who were involved in this process have become increasingly committed to the technology vision.

A clear benefit of whole school approaches, such as those described above, is the involvement of multiple stakeholders in the process of CBL integration. This works against a small group of people, or an individual, bearing responsibility for carrying out the process of integration and encourages a degree of commitment from all teachers. From our observations, we believe that CBL integration requires fundamental shifts in the core activities of the school. These shifts include new teaching practices and new agreements about how resources are distributed. A whole school approach supports successful integration because it requires all teachers to be involved in the process; encouraging a sense of ownership and support for a smoother integration.

4.2.b. Collegial approaches to professional development

A first step in the development of targeted professional development is the identification of teachers' learning needs. A number of schools reported initially surveying their staff about their technology skills and attitudes. These were used to create targeted professional development programs as a deputy principal explains:

> *Before we did our policy I did a survey of the staff on skills and attitudes.... The attitudes were very interesting, you know. You could see*

what they were frightened of [and] what they thought they were good at but didn't know how to extend laterally.

At Egan Avenue, external consultants were used to audit staff technology skills and set up graded skill checklists to guide and track computer-training programs for teachers. As part of this process, teachers were partnered with a more skilled, or less skilled, "buddy", depending on their level of expertise. Each pair then worked through training programs based on these checklists. The external consultants also worked individually with teachers less skilled in computer usage as well as with the computer co-ordinator and two other teachers with the aim of quickly building up expertise within the school.

4.2.b.i. Whole school approaches

Planning and organising professional development of teachers was identified by all schools in our study as a key issue in the successful integration of CBL. We observed different approaches to professional development that we have classified into three broad groupings: (1) ad hoc informal, (2) planned regular activities and (3) ongoing continuous support. In some schools, all three types of professional development were present.

An example of ad hoc informal support was visible at Garrison Central School. The computer coordinator described this support in the following terms,

I get on top of it, then I show someone else and then I find that 1% of the staff, then 2% of the staff, 3%, 5%, and 80%. Once you get a critical mass of the staff who know how to use it, everybody wants to use it. And there's also so many students who know how to use it, even if you're not sure, there'll be a student watching you saying 'I know how to do this!'... there may be a few failures but you can't sit back and say well now we're in charge of this equipment that's all we have to do this year. You just look for the next thing.

A teacher mentor at Tall Timbers PS described a kind of ad hoc process that was becoming incorporated into their plan for continuous support in the following terms:

> *I'm always happy to share, and anybody that's keen to learn a new program or whatever, I've always got half an hour for later on, and that's the way it's got to work. I would prefer people to get support from other colleagues because we've all got different expertise to different areas and that is starting to happen.*

An example of planned regular support was observed at Amberdale where faculties held technology workshops at regular intervals throughout the year. One aim of these workshops was to allow staff time to play and to gain familiarity: "I hold a faculty workshop one afternoon every 3 weeks with the agenda being to play with the computers" (Technology mentor/classroom teacher). Additionally these faculties received funding to write literacy programs specific to their Key Learning Areas. These have been presented on the school web site for each subject benefiting students who are now able to go to the website for assistance with the writing of reports and the analysis of data.

At Amberdale, there was also evidence of ongoing continuous support that illustrated that all three types of professional development could be present in any one school. The ongoing continuous support at Amberdale related to their whole school project which was described in section 4.2.a. The deputy principal described the professional development goals of this project in the following terms:

> *We've got a program that involves the construction of a web site and we expect every faculty to have information on the web site. We've put aside $17,500 this year to continue to work with faculties so that their planning, research units and learning units use it, not just the web site but the Internet and the technologies in the library...this is our major learning project in the school this year. It's primarily focused on training teachers and implementing in classrooms higher level research units. ...*

A theme common to all these approaches is peer mentoring. We elaborate on this approach in the next section but note here that, in comparison to the other approaches described above, mentoring had the benefit that it drew upon accessible school-based expertise. Even so, all schools in the study relied heavily upon sources of support beyond the school, including district consultants and expertise located within the local community. The curriculum coordinator at Amberdale found that attendance at external professional development courses guided and motivated the technology team to develop a technology plan:

> *Five of us went to three in-services.... And we had a lot of homework to do between those in-services and we developed a technology vision as [part of the in-service process]... we put a lot of time into doing that. Working out where our vision was going. And, it was another six or eight months later that we had to do a budget. So we developed a spreadsheet, you know, with just bubbles everywhere and we found that our technology vision was heading in about eight different directions. Some of it focused on teaching and learning, while some of it was just looking after and upgrading the equipment. We developed criteria to rate the eight different areas and we found we were lacking in the information skills side - so we had a huge push on that last year. ...*

4.2.b.ii. Mentoring

Successful mentoring programs appeared to be characterised by:

- The enthusiasm and dedication of the mentors to the program
- Mentors working collaboratively with teachers in classrooms
- Time scheduled for teachers in mentoring pairs to meet and team teach as part of their teaching load.

Amberdale GHS introduced a mentoring program funded by PSFP funds. Five teachers were designated to be mentors to other teachers, working with those

teachers or with their classes. Members of staff nominated these mentor teachers. These five teachers are characterised as having expertise in the area of technology and are seen by other staff members as genial people. Mentors are given some time release to assist other teachers. Teachers either ask mentors for help or mentors have on occasion, targeted teachers. The mentoring tends to be conducted in an informal way. Ideally teachers will plan a unit together and then co-teach it, but timetable constraints have made that difficult. In one interview a mentor discussed assisting another teacher with pedagogical aspects of using computer-based learning as well as skill development. He stated that his aim was:

> *To actually use technology and bring it into the lessons, [to] integrate it. So what we've built is a unit which would have [been] taught in that subject at that point in time, but by putting a technology focus in [the mentoree] becomes familiar with the use of technology. (Social Sciences teacher and technology mentor)*

A teacher at Coalfield Cliffs PS described the mentoring program and why it was successful for her.

> *We had two terrific teachers, I call them mentors. That first year we did a lot of mentoring where the two teachers with the expertise mentored everybody here.*
>
> *In my classroom we started with some De Bono thinking strategies with the kids, then working towards setting HyperStudio Stacks. Then we got to the stage where our classes buddied up and worked on stacks together. The 4/5 kids taught my Kinder kids. The older kids were used as the extra hands to make it [the integration of computers] happen, because I couldn't split myself into 5 people. My role was to oversee the set-up, deal with technological hitches. I knew how Hyperstudio worked, so for me it was more learning about the structure and that style of learning. It was learning how to go from the stage of: this is how I envisage using computers in the classroom, to: I can do it, this is it. This is exactly what I see as the way I want it to go in my classroom and the way I see the*

learning as best happening. I've seen the mentors now move on to other schools but I'm still going with what I gained out of it. For me it was learning how to go from my ideals, to how I can do it in the classroom. I wanted computers to be integrated and I didn't know how to make this happen. Tracey showed me how to do this. (Kindergarten teacher)

Egan Avenue PS used team teaching to mentor staff. A mentor at this school commented:

We could see that a lot of the teachers' skills were pretty low and we had to uplift them as well, and we had to do it in a way that was non-threatening. So doing the team teaching was a good way of doing it in a non-threatening way so they became encouraged to do it in their classrooms.

In the same school a teacher who had been mentored through team teaching stated:

I was lucky because I worked with ... and she was terrific, absolutely amazing! She had 5/6 and I had 6 ... but her kids were way ahead of mine and I didn't understand why. But I went to her and she spoke to me about it and ...I went into her classroom and ... I realised that I was not giving them technology teaching – just letting them do it.

Effective mentoring appeared to depend on good interpersonal relationships. A teacher from Amberdale GHS summed this up in the following way:

I think it's that knowing each other makes a difference. It wasn't like someone outside coming in and saying, "You do this". I sort of said "Oh, I've got an idea for your outback class, do you want to have a play with it?" And it was introduced that way. I said, "Oh, have you seen this stuff... it looks interesting." So we did it from that sort of base ...[likewise] with the faculty I'm working with, ...I've worked with those people for a lot of years too. ... I brought them down and showed them the web page and some of the stuff on the web page. And I'll sort of grab

> *a couple of those too, one or two depending on the time, and say, "Look do you want to have a play?" And that's the approach I'm taking and I've not had any problems with it.*

A teacher at Tall Timbers PS recognised the helpful roles played by those teachers trained as mentors. He enthused:

> *We are particularly lucky in that we have [colleagues] who are absolutely fantastic and incredibly generous with their time... You know we've got quite a few people in the school with expertise. I mean, three or four that you could ask anything and they'd be capable of telling people all the different answers and solve problems very quickly. So we're very, very lucky.*

From the point of view of a mentor at Amberdale GHS, assisting others with the development of the web page for their subjects was helpful in providing her with information about the professional development needs of her colleagues:

> *I feel good about the fact that I know where a lot of faculties are going and what their problems are. Who's interested and who needs extra help and things like that. But it was only by having time to talk with people that this actually happens.*

Our observations suggest that mentoring is an effective professional development tool because it enhances teachers' sense of belonging to a professional learning community. By acknowledging the expertise of individuals and by providing a mechanism for them to share their expertise with colleagues it appears to build the confidence of those involved as well as their commitment to the integration of CBL. Additionally it provides the sustained onsite support and individual assistance needed for effective teacher professional development (cf. Collis and Carleer, 1992; Swetman and Baird, 1998).

In order to support mentor relationships aimed at enhancing the integration of CBL, we recommend that schools be encouraged and supported to make provision for mentors and mentorees to work together on developing and co-teaching integrated curriculum ideas and that a suitable time allowance be provided for this process.

4.3. Synthesis of the views of key stakeholders involved in the integration of computer-based technologies across the curriculum

4.3.a. Teachers' understandings of the influence of CBL on pedagogical practices

Our observations indicate that teachers are largely under utilising the computers available in their schools (cf. Marcinkiewicz, 1993). They tended to integrate CBT in ways that supplemented existing learning designs, often by utilising CBT to provide similar tasks to those implemented without its use. The CBT frequently functioned as an assistant teacher, freeing up the classroom teacher to work on a one-to-one level with students or small groups not engaged with CBL. These observations were confirmed during our interviews with teachers, as most indicated that CBT had *not* fundamentally changed the ways in which they teach or the ways they design/plan learning experiences within the classroom.

Although there is some evidence in the literature to suggest that the integration of CBL is associated with a shift from instructivist to constructivist philosophies of teaching and learning (see section 3.2 page 31), it was clear from some of the interview material that teachers would adapt their teaching to the context in similar ways in both CBL and other learning contexts. For example, one computer coordinator explained her approach to a lesson when asked if computer technology had changed the way she planned a learning program:

> *Oh yes. It's very highly structured as you saw. The reason for that was to keep them moving within the lesson. If I was thinking about the same*

lesson, if you just gave them the research topic it would take an enormous amount of time for them to get to base one, just to find a site which had some information on. That's why I gave them three starting points [websites]. It is only just to give them three starting points so that from there they can [go] wherever they like. But, if you were to unstructure the whole thing, which ... a lot of my science lessons are fairly unstructured, and you can go off on tangents and things where you can.... In computing studies, you can do the same thing. But when you're actually trying to teach a particular skill on the computers, I'd keep it really structured. So yes the planning is different.

I mean, at different times, if I'm teaching, if I'm trying to teach a particular skill within a particular time, like, say I'm also teaching that same class how to solder. Alright? Well, they have worksheets on how to solder. And we went through it step by step with a whole um class following instructions. ... because the detail the instructions they had to follow were very detailed. You know, like, if you get a capacitor round the wrong way the whole circuit's not going to work. So the whole idea of having it fairly structured is to eliminate some of those problems. And the other thing is also I did I wouldn't correct the girls' circuits. They had to actually work it out themselves or check it within themselves otherwise they'd just be having a go and bringing out and saying: is this right Miss. You know

So yes. There some things I do highly structured otherwise I don't. Quite a lot I don't. So yes. Try and keep it fairly varied.

This teacher used the computer in ways that suited the demands of the particular situation in the lesson, but did not fundamentally alter her teaching style. In contrast, it is the view of the Physical Support Unit teachers at Tall Timbers PS that use of CBL has completely changed the way they teach and the way the children learn. In their view, this change is possible because there is now one computer per child and special peripheral equipment and software that allows the children to operate their computers independently of their teacher.

The severe physical disabilities faced by some of the children make the contributions of computers essential in developing the children's independent learning processes. As one of the learning support teachers explained:

> *Any of these children that need to write to do anything can only use the computer because they have no hand functions. So for maths, they can't use their hands to count or actually manipulate objects so quite often it's all done on the computer.... Computers have opened up opportunities that they otherwise wouldn't have.*

As a result, one of the teachers reported that he saw his way of teaching now as being much more child-centred rather than teacher-directed. He said:

> *So there's a lot more children-centred learning. And I suppose it's more hands-on for them and I've really become more a facilitator for them. Whereas they just work at their level...I suppose you've still got your input and you have to find the different programs, activities and set them up. So, but, it's totally changed. I mean, you've got to become more adept at technology and understanding this. It's totally changed it.*

In this Physical Support Teacher's view, the changes in technology have not only made changes in how he teaches, but also made it possible for children to learn things that they could not learn due to their severe physical disabilities.

> *I mean, that they have thought up absolutely wonderful things for our children to use. That enables them to be able to write or type. I had a girl in my class last year, that oh, for years, she's now in high school, for years, hadn't been able to do anything. She couldn't use- Her only function was to move hands like this. (Unable) to use the switch. And now she's writing simple sentences. But four or five years ago she couldn't have done that.*

Using the available computers, teachers within the Physical Support Unit could change their previous classroom structure from one teacher teaching a small group of children dependent upon that teacher, to that teacher assisting children working

independently at their own computers. And it was not only the teaching design that changed. A variety of new outcomes for the students became possible: producing their own work and becoming independent of the teacher. It was the teacher's view that:

> *Children have moved from mostly groupwork (because they can't do anything for themselves, e.g., scribing, guessing, hoping) to working at an individual level- more suited to each child's independent level of achievement, rather than a group level. It has also changed their level of independency - the work they're producing is theirs, not mine.*

In summary, technology within this context made a tremendous impact on the children's independence as well as the teacher's accuracy in assessing and planning learning experiences for the students. The teachers were able to teach in a more student-centred way and design individual learning programs for each child. The take up of technology by teachers of children with special needs does stand in stark contrast to its take up by teachers in regular classrooms. It was clear that the former were compelled to experiment with CBL because of the new opportunities it afforded to students with special needs. The fact that these teachers generally have much lower teacher-student ratios may also contribute to their preparedness to experiment with CBL.

However, for the majority of teachers, technology presence in the school did not affect their teaching; it was for many an afterthought rather than part of their planning. As one Principal explains:

> *Because I'm beginning to use it more, I begin to see the extended possibilities. And it can be overwhelming but I've got to keep saying to my staff that the more you get into this the more your vision will expand.*

In order to assist teachers in expanding their vision for technology integration in the classroom, there is the need for support such as that described by the Principal above and the need for professional development. There is also the need for uptake pressure. Ideally this would take the form of increased motivation for

integration due to a belief in its benefits, as demonstrated by the special needs teachers we observed, but also needs to be present in other forms. For example, one curriculum coordinator suggested that integrating IT into assessment requirements placed uptake pressure on teachers:

> *By putting it in the assessment policy it makes it happen. If you just want things to happen without it being assessed... you get a few interested students but most people just step back.*

Support and pressure must be accompanied by professional development. We cannot overstate the perceived need for more professional development opportunities related to CBL integration. Statements such as the following were echoed throughout each school.

> *I really think teachers in general need training in Internet use. Not just a TILT program but some intensive work in how to use the Internet. And how to use it effectively. And to use it effectively in the classroom...*

> *Classroom teachers need some training in information literacy. And in terms of the Internet, in terms of CD-ROMs technology, all that technological stuff and how to pass that on to their kids. I mean, all credit to the government for what they've given us in terms of hardware but we really need some training support.*

Tobin (1992) identified almost a decade ago that there needs to be some resonance between teachers' views about learning and the pedagogical underpinnings of CBL integration. In the light of our observations, we suggest that this is a message that still goes largely unheeded.

We recommend that the integration of CBL be embedded within a broader focus on quality teaching and learning that provides opportunities for teachers to reflect upon their approaches to teaching and the nature of learning.

4.3.b. Students' use of computers

Overall computers appeared to have a very positive and motivating impact on students. In this section we present some ways the case study schools motivated students, highlighting the particular benefits for students with special needs. In some schools, students became mentors to other students and even to staff. We also note that extended use of computers in schools is of high value for students who do not have access to a computer at home.

4.3.b.i. Motivational effects

Teachers noted many motivational effects that they attributed to use of computers. These effects ranged from the stimulation of being able to finish work to a high standard of presentation, to develop autonomy in learning and to actually want to learn in new, different and exciting ways. As a librarian at Garrison CS stated:

> *The children get something finished and they have got a really high standard of finished work. And they're so proud of it: They're rushing around the school, dashing around the school to show other people. And they're dying to get it finished so that they can get (theirs) up on the wall.*

Autonomy in learning can be highly motivational, provided the necessary support is also present. Real benefits in using computer technology for encouraging student autonomy were also noted by the librarian at Amberdale GHS:

> *One of the really exciting things is they can do it so easily and they can learn to teach themselves. I mean, you know how computer literate kids are, they don't read the manual. They just sit down and they do it and they find their way through and that's very empowering particularly for our girls, you know, coming a lot - 80 to 90 percent – from non-English speaking background. So it's giving the girls a control that is really good. Really good for their self-esteem and their learning.*

Teachers at Egan Avenue PS also stated that children found using the computer motivating and exciting, that they could use the computer to produce very

presentable work and that they "did not know they were learning". In one class, the teacher reported that the chance of using the computer provided an incentive for children to complete their work so that they could use the Internet for searching. Teachers recognised that by allowing children to use the computer, they were assisting the children to work more independently. One teacher stated that becoming an expert in using the computer gave children who were poor at English and Mathematics a chance to be successful and highly regarded in the classroom.

Other teachers noted children's pleasure in using computers and that motivation and learning could be so closely intertwined when children were using computers that it was difficult to separate the two. They commented:

> *They love it! (Classroom teacher)*

> *I don't know if it improves their learning but it's just different and reinforcing. I think that's what I try to do ... reinforcement so you're still teaching the basic. ... This is just extra. We've already done Eureka Stockade but we're just presenting it in a different way. (Classroom teacher)*

> *It does impact (on their learning) because it makes the kids really interested in what they're doing. I don't have any games in the technology room and you'll never hear them say "Its boring" or "I don't like" anything. (Classroom teacher)*

These motivational effects were present to a high degree in students with special needs, as we indicate in the following section.

4.3.b.ii. Students with special needs

The learning support teachers at Tall Timbers PS were delighted with the very positive effect that they perceived CBL had on the children's attitudes to learning. The use of computers for these children was highly motivating in that the end product was far more presentable than anything they could do by hand; as a result,

pride in their work was considerably increased. In addition, with a computer for each child and specialised equipment, teachers could more easily access children's knowledge. As one of the teachers related:

> *One of the nice things I think about the music computers is that they've got something nice to show at the end of the day and it really is their work whereas in the past there has to be a lot of guess work as to what they really know and what they're trying to say and this does in fact pinpoint what they actually know.*

Another learning support teacher also commented on the increased motivation and enjoyment that the children display, simply through computer use. He said:

> *And of course, it's a more exciting medium than they're used to. Actually, they're used to a lot of stimulation, I suppose. But the computers are something they really enjoy. I mean, they don't have many pleasures, disabled children really. There are very few, very few things that they can really do. And computer's the one thing that they can. Opens a lot of avenues and opportunities for them, so it's probably one of the things that they can enjoy. Probably very few recreations that they can do on their own.*

In short, children at this school enjoyed using computers as part of their work and the complete integration of computers into the learning environment of the Physical Support Unit has resulted in teachers and children being highly motivated by their processes and products.

4.3.b.iii. Student mentors

At Coalfield Cliffs PS a student mentor program involves Year 3 students coaching Kindergarten students in the software *Wiggleworks* and Year 6 children coaching Year 3 students with *Hyperstudio*. The student-mentoring program runs in term 3 and 4 each year.

At another school, Year 2 teachers reported enthusiastically on the success of the "pre-school buddies" program in which Year 2 students act as the experts helping preschool children to use the computers to undertake story publication.

In the above examples primary school children mentored other primary school children however, at Amberdale GHS Year 10 students taking Computer Studies mentored students and teachers at feeder primary schools. The Year 10 students were given assignments which included mentoring staff and students in the use of the Internet and software applications. The computer teacher reported:

> *Our Year 10 students evaluated the software and they made a set of instructions for the software, suitable for the age group of the children who are actually using the software. The next [part] of this [is that] they will go down to the primary school and actually teach the kids how to do that.*
>
> *The next assessment will be developing a training package on how to use the Internet. ... They've been given guidelines and things already. ... They can target a particular audience from kindergarten up to high school teachers and they will actually be expected to teach some of this to people. This is to do with the changing over of Apple ClarisWorks to Apple Works on the network. So we thought we'd have some familiarisation assignments*

These assignments are seen as having a number of benefits including "developing leadership skills in our girls".

At Tall Timbers PS the principal's view is that students can be experts and assist teachers. He stated:

> *Now probably the most capable scanner is a Year 3 girl. And she's training up kids and staff.*

In summary, the integration of computers in the curriculum appears to have benefits for students of which some of the most powerful are their motivational

effects on learning. These effects can lead to students engaging in deep learning, in becoming autonomous learners and in providing opportunities to take on mentoring and leadership roles within their classroom and whole school.

Whilst such benefits were provided in some classes, we also observed classes where technology appeared to be impeding learning due to a range of factors. These included slow startup and Internet access, technical problems with individual computers, repetitive tasks and limited access to computers that were sometimes shared by up to four students. Clearly a number of these issues relate to the need for students to have access to reliable computers at a reasonable ratio. It also highlights a finding noted in the literature review that teachers tend to integrate technology in ways consistent with their concerns for classroom management, rather than to meet instructional objectives (Gerber, Semmel and Semmel, 1989).

4.4. Rich descriptive examples of the current use of computer-based technologies for teaching and learning in schools

The following are some descriptions of how case study schools use CBL in exemplary ways. We are not suggesting that these are the only examples of exemplary teaching that we observed in the case study schools but that these examples illustrate some features of exemplary CBL integration:

- Multimedia project work (4.4.a) that illustrates open ended learning activities and higher order thinking (Fiske, 1998);
- Use of email to enhance learning (4.4.b) that illustrates increased opportunities for discussion and shared understanding by keeping track of dialogue and maintaining an archive of discussion (Blumenfeld, Marx, Soloway and Krajcik, 1996);
- Year 7 literacy room (4.4.c) that illustrates interdisciplinary thematic units structured by team teaching and cooperative learning (Fogarty, 1991);

4.4.a. Multimedia project work

At Coalfield Cliffs PS we observed a collaborative approach to integrating computers in HSIE, that utilised the *HyperStudio* multimedia package. This approach illustrates open ended learning activities and higher order thinking (Fiske, 1998); The stages of the process are as follows:

I. Brainstorm a topic

II. Organise small groups

III. Create a concept map

IV. Set goals: Content, Technology and Learning together

V. Devise roles, rules and responsibilities

VI. Construct a flow chart

VII. Research information

VIII. Publish and create multi-media project

IX. Evaluate a project using De Bono's thinking hats

X. Devise, literal, inferential, critical and creative questions to support your work

XI. Share your project. Can others answer your questions?

XII. Peer evaluation: What do other groups think of your work?

In the classes observed, children started this process as a whole class and then worked in teams of five or six following the process as a group. Each team had access to a computer, scanner and digital camera. In the classes observed students were very focused with the majority on task, motivated and proud of their work. The classes were very student-centred as illustrated by the involvement of students in decision making at each step of the process. Students were familiar

with the process and documented each step. All groups seemed to have a good understanding of the process, knowing what they were doing and why they were doing it. This approach could have been implemented without CBT but its utilisation with CBT enabled multiple articulations of the students' work that could be easily updated, linked to information via the Internet and shared with an audience beyond the classroom.

4.4.b. Use of e-mail to enhance learning

Computer e-mail is being used as a means for providing students with individualised learning programs at Garrison CS. A teacher we spoke with has established Hotmail accounts for each of her students. Students e-mail their completed tasks to the teacher who then marks them, gives feedback and returns the work via e-mail. The e-mail received by each student is then the basis of his or her work for the next lesson. In this way the lesson for each student becomes more individualised and contextualised, as the teacher explains.

> *With the new English syllabus, the focus is not so much on the literature, anymore, as on the context that we use English in. And part of that is for the students to understand that the English language changes according to the context we use it in. So in order to broaden their experience of the various types of English we're using I started up an email system with them, so that they get used to using email English, which is very much like spoken English.*
>
> *It provides more options! You can more individually target students. If it was a writing task, for example that I wanted them to respond in a particular way I would actually change the questions according to what each student needed to do. In terms of their skill levels and where I wanted them to improve or what I wanted them to do. It's far more individualised. They still interact with each other in class, they still communicate what they've got to do, they still talk to each other, but the work that they have to produce, is more individually targeted at what they need to do. So in a lot of ways the computer is a way to give them*

individual instruction, it doesn't take the place of whole class teaching it's an adjunct to it. (English/History teacher)

This example illustrates how email can afford increased opportunities for discussion and shared understanding by keeping track of dialogue and maintaining an archive of discussion (cf. Blumenfeld, Marx, Soloway and Krajcik, 1996).

4.4.c. Year 7 Literacy room

Newbridge HS has introduced a year 7 literacy room into the school that illustrates interdisciplinary thematic units structured by team teaching and cooperative learning (cf. Fogarty, 1991). A literacy teacher (paid by PSFP), a teacher's aide (also paid by PSFP) and the regular KLA class teacher staff the literacy room. During most periods the Support Teacher, Learning Difficulties (STLD) is also present. There are also nine computers. Each student attends the literacy room for nine lessons per fortnight. Three of these lessons are with their Science teacher, two with their English teacher, two with their Mathematics teacher and two with their HSIE teacher.

Whilst many literacy skills apply across KLA areas, some are more relevant to certain parts of the curriculum. For instance in English describers (adjectives that describe attitudes or feelings) are important but classifiers (adjectives that classify) are more important in science. There is a difference in the appropriateness of these word functions to different KLA areas. Equal emphasis is placed on the literacy demands of all four KLA areas over the course of the year.

In the literacy room, the students cycle through homework, reading and computer-based activities. They work in groups of about eight under the supervision of either a teacher or teacher's aide. The activities are interrelated. For example, the students might select a reading from a collection of texts, chosen by the teacher from the library or from popular texts such as newspapers, then after reading for 10-15 minutes they move to the computers where they write a daily reflection on what they have read. This is a critical reflection about what they enjoyed, disliked

and learned. Additionally, the homework activity builds off the readings and develops their critical literacy and writing skills. According to their teacher:

> *Kids like computers but they don't like reading and they don't like writing, so what I've done is use computers to teach reading and writing. (Literacy Teacher)*

Early in the year, the literacy teacher utilises computers as a tool for teaching basic skills like spelling, punctuation and the use of capital letters by using a basic word processor without a spell check. This is followed by the use of Microsoft Word, later in the year, which assists with spelling and proof reading.

These examples illustrate how CBT can be integrated into the classroom in ways that capitalise on the new learning opportunities provided by CBL. We therefore emphasise the importance of professional development aimed at helping teachers with enhanced pedagogical skills to move beyond simple incorporation of CBT.

4.5. The CBL integration threshold: Analysis of findings

In this chapter we have provided a broad ranging description of key issues related to the integration of CBL that we encountered during our visits to the six case study schools. Informed by these findings, we present here a preliminary model for understanding the process of CBL integration in schools.

- *Successful integration of CBL leads to enhanced learning*

As illustrated in the previous section, some of the teachers in our study demonstrated pedagogical capabilities that enabled them to integrate CBT in ways that enhanced students' learning opportunities. However, for the most part, we observed classrooms in which computers were used as a comparable alternative activity. In other words, students working with computers were doing similar tasks to students sitting in the same classroom working with pen and paper and

these activities did not generally emphasise higher order thinking, deep knowledge or substantive conversation.

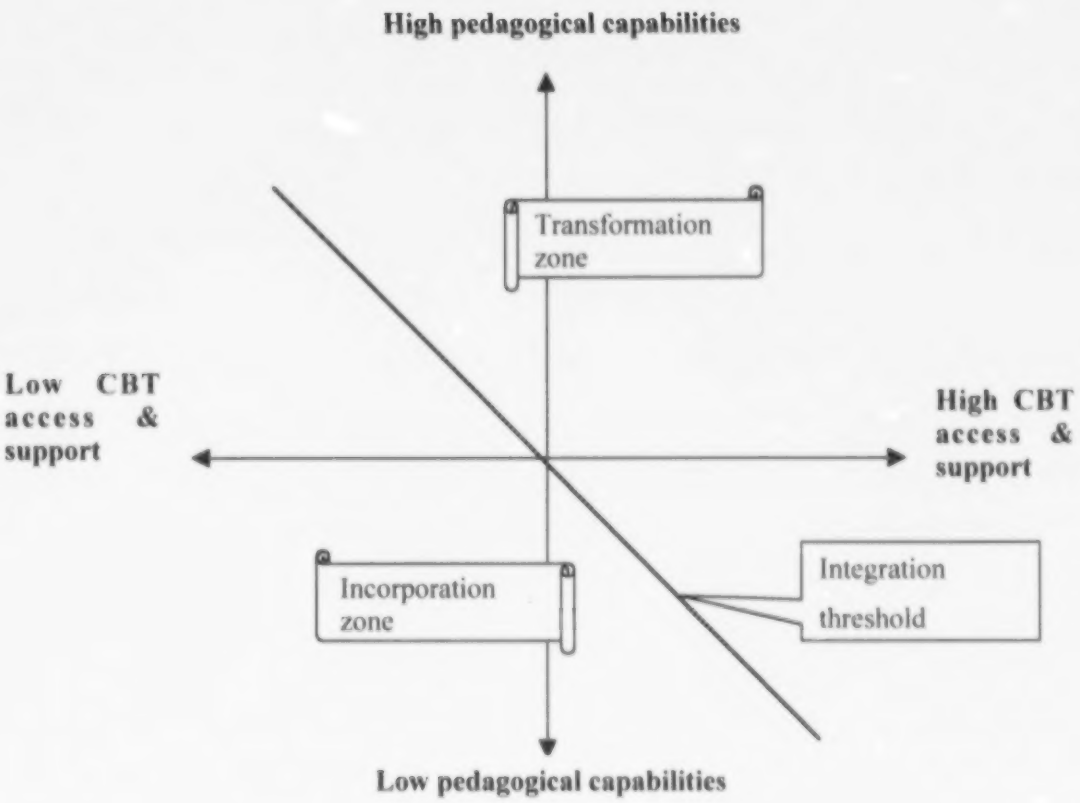
We do not believe that this situation is limited to the case study schools because it aligns with the findings of another recent Australian study which concluded that "the substance of learning and teaching remains more or less the same as it was in the 'pre-computer era', only now 'technologised' under a new technology regime, machines having replaced pens" (Lankshear, Snyder & Green, 2000, p.22).

- *Supporting teachers leads to successful integration of CBL*

Our report emphasises that the most important factor affecting the outcomes of CBL is not the kind of technology used but the design of the learning experience that makes use of the technology. Teachers with high pedagogical skills appear able to exploit the most basic of CBT to create new learning benefits (Laurillard, Stratfold, Lickin, Plowman, & Taylor, 2000). However, a technology enriched environment is unlikely to improve the effectiveness of teachers with low pedagogical capabilities (Collis,1996a). Additionally we acknowledge the powerful effect of leadership support on the integration of CBL. Our observations suggest that all teachers can utilise technology more effectively when they have strong support from school leaders and this support appears to be most effective when it is focused on enhancing learning.

- *A well-supported goal to enhance learning enables successful integration of CBL*

Taking these factors into account, we argue that there is an *integration threshold* below which CBT is simply incorporated into the curriculum and above which it has a transformative effect. We have attempted to represent this visually in the grid below with the integration threshold idealised as a sliding straight line.



Our findings suggest that currently the incorporation zone is much larger than the transformation zone. Within this zone there is great variation in the quality of CBL integration. Exemplary CBL integration requires well coordinated whole school projects focused on improving learning through quality teaching that is facilitated by access to well supported technology. Our observations also suggest that transformative applications of CBT are limited to situations where there are high pedagogical capabilities and high levels of CBT access and support. The next section clarifies further what we mean by pedagogical capabilities and links the way teachers' approaches to pedagogy are linked to their views of learning.

5. Findings from classroom observations and their interpretation

Our purposes in this section are twofold:

- To describe the classroom practices of teachers in the participating schools in terms of our chosen observation instrument (previously outlined in section 2.1.a) that details the extent to which the five *Standards of Authentic Pedagogy: Instruction* are present in classrooms, and
- To interpret our classroom observations through an examination of the models of learners' minds offered by Bruner (1996), by examining the theories and principles of learning in which teachers have either implicitly or explicitly grounded their pedagogies.

5.1. Description of classroom practices

One of the principles that guided the development of our research design was expressed in our proposal in the following way:

> Learning programs that require students to think, to develop in-depth understanding, and to apply academic learning to important, realistic problems boost student achievement equitably for students from all social backgrounds (Newman and Wehlage, 1995).

⇒ Arising out of this guiding concept this research proposes using a classroom **observation instrument** to identify and describe the forms of instruction, utilising computer-based technologies, that are enhancing student learning opportunities. The standards of "authentic pedagogy" elaborated by Newman and Wehlage (1995) will be adapted and expanded for use in this study because these standards have been shown to boost student achievement equitably for students of all social backgrounds.

The information gained from our classroom observations was described in qualitative terms in the previous section. In this section, we describe a one sample t-test comparison of our classrooms in New South Wales (n = 25) with a tentative standard based on the very large Queensland School Reform Longitudinal Study (n = 975). The QSRLS sample is sufficiently large for us to use as a representation of the population. Both the NSW and Queensland studies were conducted in a range of government schools. Apart from size and location, the most distinctive difference in the two studies is the presence of CBT in the classrooms that comprise the NSW sample.

Collectively the NSW sample is significantly lower than the population represented by the QSRLS on higher order thinking, depth of knowledge and substantive conversation. The t-test comparison of means on these items are, respectively: $t(25)= 2.239$, $p <.05$; $t(25) = 3.815$, $p < .01$; $t(25) = 2.486$, $p <.05$ (see technical note[1]). These are t-tests of single mean results comparing the sample means to the population mean estimated from the QSRLS data. This suggests that current CBL teaching strategies may afford less opportunity for higher order thinking, deep knowledge and substantive conversations than classrooms where CBL is not being integrated. Additionally, the NSW schools scored higher on connectedness than in the population ($t(25)= 2.291$, $p < .05$).

This is a preliminary attempt to begin to describe in more quantitative terms the impact of CBL integration on teaching practices. The small number of observations and observers, combined with possible subsample effects, suggest that we treat these comparisons cautiously. Even so, they have been included here because of their potential contribution to future research directions and because they provide a different, albeit speculative, lens through which to view the qualitative data.

[1] Data was examined for violation of the assumptions of t-tests. Given the sample size, the data appeared to be relatively normal, did not suffer from extreme skew, or kurtosis, and had no substantial outliers.

It is more difficult to make individual school comparisons with the larger population but we have attempted to ask the question: Does the school differ from the population? Coalfield Cliffs Primary School and Newbridge High School have too few observations to be able to give a direct answer to this question but, in general, the other schools individually are not significantly different from the QSRLS population scores.

This seems to be consistent with our analysis of the qualitative data. It is interesting that the connectedness score is in general higher than QSRLS, although not significantly so at the school level. It is also interesting to note that Coalfield Cliffs Primary School, where we observed the multi-media project, stands out as consistently high on all scores but, because this is a single observation, no further comparison can be made with the population.

It is important to note that teachers were attempting to integrate computer-based technology in all the classrooms in the NSW study, whereas this was the case in a very small number of classes in the Queensland study. It is likely that issues associated with this integration may account for the differences in the samples and our previous description of a range of findings from our study offers some insight into the nature of these issues (see chapter 5). This quantitative comparison hints at what the effects of these issues are on pedagogical practices.

We recommend that future research monitor the effects of CBL on teaching practices and attempt to describe in greater detail how teachers' attempts to integrate CBT impact on their pedagogical repertoire.

5.2. Interpretation of classroom practices

In this section we interpret our descriptions of classroom practices through models of learners' minds as outlined by Bruner (1996). According to Bruner (1996), four models of learners' minds have been responsible for the ways in which theories and practices of teaching have developed in our times. Bruner describes these models as:

- Seeing children as imitative learners
- Seeing children as learning from didactic exposure
- Seeing children as thinkers: the development of intersubjective interchange
- Children as knowledgeable: the management of objective knowledge

We will briefly describe each of these models and link them to some descriptions of lessons we have viewed and to the *Scales of Authentic Pedagogy*. It needs to be noted that teachers' beliefs and assumptions about learning and teaching are complex and that neither we nor Bruner (1996) claim that they fit neatly into single categories such as those above.

5.2.a. Seeing children as imitative learners

This model of learners' minds assumes that a teacher's modeling an action or procedure will allow children to learn that procedure by being shown and through subsequent practice. Implicit assumptions are that children do not already know how to undertake the procedure, that they desire to learn the procedure and that they are trying to succeed. An apprenticeship view of learning is inherent in this model, where competence develops from practice. In this view, there is a "right" way of performance.

Links to lesson descriptions

Teachers' beliefs in this assumption were apparent in a number of the lessons that we viewed. During lessons in classrooms where there was a small number of computers or in computer laboratories, we noticed teachers informing children about correct computer usage. This included ways of turning computers on and off, correct ways of inserting floppy discs, correct ways of using the keyboard and correct ways of using applications such as PowerPoint. Children then had opportunities to practice their newly learned skills.

As with many procedures, in some cases such exactitude is absolutely necessary, where damage to either equipment or to the children themselves might eventuate if correct and safe procedures are not followed exactly. It is only where this is the major way of teaching that the learning is limited. Teachers can be explicitly aware of the wisdom of using this strategy under suitable circumstances. For example, one teacher suggested that the approach used depended on the desired learning outcomes. She stated that she used methods of telling and then allowing practice in situations where she wanted students to learn a particular skill in a particular time for example, when teaching soldering skills.

Links to the Scales of Authentic Pedagogy

Low scores on the scales measuring the presence of higher order thinking, the development of deep knowledge, classroom discourse devoted to creating or negotiating understandings of subject matter and student-centred teaching are readily explained if the teachers have an apprenticeship view of learning. Such a view readily manifests itself in a computer-mediated classroom environment where teachers believe their task is to teach the skills needed to use computer technology.

In short, low scores on the Scales of Authentic Pedagogy can reflect a view of learning that implies that knowledge develops through practice, not through conceptual explanation that might allow learners to develop greater flexibility in considering in which other ways skills might be developed.

5.2.b. Seeing children as learning from didactic exposure: The acquisition of propositional knowledge

This widely held assumption views knowledge as residing in the head of the teacher and in sources such as books. Teaching therefore, has the role of knowledge transfer from its source to the minds of the children. Those who ascribe to this view assume children learn facts, theories and principles through being told or through having access to information sources. Initially it is assumed children do not know and after exposure to the information, they will acquire it if

they are intelligent enough. It is also assumed that after acquiring such factual knowledge, children will be able to apply it to new situations without explicit teaching. So-called "transmission theories of learning" fit into this model. This view of learning is endemic and of course it is not completely false. There are obviously situations where factual knowledge can be learned in just these ways.

Links to lesson descriptions

Several of the lessons that we viewed emphasised teachers as the imparters of knowledge and children as the receivers as both teachers and children stayed within their designated role. For example, in one classroom, where the children were working with some mathematics software, they were unsure of how to proceed. They did not seem to feel that they should try to work out how to use the software but expressed irritation that the teacher had not told them what to do. Responsibility for learning seemed to lie with the teacher not the students.

Links to the Scales of Authentic Pedagogy

Teachers' beliefs in a transmissive view of learning are reflected by low scores on the scales measuring the presence of higher order thinking, the development of deep knowledge, classroom discourse devoted to creating or negotiating understandings of subject matter and student-centred teaching in their classrooms.

Thus if it is assumed that learning through being told is the only way children learn, then it follows that learning is a passive process. The children's role is to listen quietly and allow their empty minds to be filled. The notion of children's minds needing to participate actively in the learning process, the notion of dialogue and mutual exchange of views is excluded and hence low scores on the Scales of Authentic Pedagogy are inevitable.

5.2.c. Seeing children as thinkers: the development of intersubjective interchange

In this view, the teacher recognises that children, like adults, are capable of constructing a model of the world that helps them interpret their experience. An

important role of the teacher is to acknowledge that children are capable of thinking about their thinking and hence on reflecting about their experiences. The role of the teacher becomes one of understanding the child's perspective in the learning process. Hence pedagogy depends upon discussion and interaction in which knowledge can be constructed and in which it is acknowledged that adults and children can have diverse points of view. To arbitrate between conflicting points of view, evidence for a viewpoint needs to be presented and knowledge that is accepted as true must be based upon such evidence and justification of belief. The authority of the teacher or text does not determine truth.

This model of education differs from the previous two in that it assumes a different view of knowledge. It is not assumed in this model that knowledge is fixed and independent of knowers' perspectives. In this model, a community has constructed knowledge within certain historical time and knowledge is accepted as true because it has been tested through consideration of evidence and existing knowledge. Constructivists would view learning and knowledge in this way.

A criticism of this perspective is that it can lapse into relativism, where knowledge is assumed to be true if there is a community that accepts it as true. This view of knowledge construction can lead to overestimation of the importance of knowledge construction through dialogue. It can be assumed that as long as evidence is presented for a view or belief or explanation of a situation, then one such explanation is as good as another, even if the belief or explanation conflicts with knowledge that has been developed in the historical past and that has stood the test of time.

Links to lesson descriptions

As we indicated previously, we do not assume that teachers operate according to only one of Bruner's models of mind and therefore their pedagogy is complexly linked to more than one assumption. For example in one lesson observed at Tall Timbers PS the teacher assumed that children gain knowledge from reliable information sources. In presenting a variety of information sources to the children, the teacher implicitly encouraged the children to believe that information found in

books and the websites she had chosen were reliable sources of knowledge and that children do not have a role in questioning the reliability of the source.

In the lesson we viewed, the teacher did not offer the children the opportunity to contribute their own personal knowledge to the subject of Frogs (although she may have done so in previous lessons where we were not present). However, in allowing children to choose their own sources of information for their project, the teacher also demonstrated that she is operating in part from Bruner's model described in this section. She is seeing the children as thinkers, capable of making sensible choices within the limits she has set and capable of negotiating within their groups to include relevant information into their project.

Links to the Scales of Authentic Pedagogy

High scores on the Scales of Authentic Pedagogy would reflect teachers with views consistent with a model of a learner's mind as described here. In particular, high scores on the scale of the *extent to which classroom discourse is devoted to creating or negotiating understandings of subject matter* would be anticipated.

So teachers with this view of learning would be expected to provide their students with many opportunities for knowledge construction. While high readings on some of the Scales of Authentic Pedagogy would be expected in such classrooms, researchers would need to be alert to identify whether the classroom community was accepting a relativistic view of knowledge.

5.2.d. Children as knowledgeable: The management of objective knowledge

According to Bruner (1996), an ideal pedagogy is one that draws on the third model, in that it treats dialogue seriously as a legitimate form of knowledge construction, but one that goes much further to recognise the reliability of cultural knowledge and the reluctance of the culture to change knowledge that has been accepted over historical time. Pedagogy drawn from this view would be one that encourages children to draw links between their personal experience and the knowledge of the culture and hence to gain a much deeper understanding of that

cultural knowledge and how it came to be accepted. In this sort of model of learning there is a place for the teacher or some knowing other to play a role in mediating the learning. However, the role of the "expert" differs from that described in section 5.2.b in that the person who is more knowing is a mediator rather than a transmitter of knowledge and knowledge is viewed as socially and historically constructed as opposed to being immutable. Both students and teacher can act as more capable others. This model represents a socio-cultural view of learning and knowledge.

Links to lesson descriptions

Although in a relative minority, interesting examples of this model were apparent in the lessons seen and described. Furthermore, aspects of this model were reflected in the culture of the school through the mentoring programs that were being encouraged. For example, in one lesson, a teacher recognised that the children were more likely to be expert at using some software than she was and she encouraged them to investigate the software and work out how it was to be used. This approach acknowledges that the children will be coming into the classroom with their own cultural experiences and understandings and these understandings should be valued by others in the classroom.

In another lesson, students studied a number of websites and collaboratively decided how these websites could be judged for their value and reliability for that particular group. Students used both personal experiences and cultural understandings to decide on the credibility of the websites. For example, knowing that a large international corporation had sponsored a site or that the site had won awards from associations met the students' criteria for indicating that the site was credible.

Another example that seems to fit in this model was one in which students assumed the role of the "expert". Many schools had examples of students acting as mentors to other students, teachers and students from other schools. Teachers who encouraged such mentoring were acknowledging that the students were independent, knowledgeable thinkers who had developed understandings as a

result of their experiences and were able to support others in developing such understandings. (Our understanding of mentoring is that it is a reciprocal relationship in which both mentor and mentoree stand to benefit from their interactions: the mentoree by gaining increasing knowledge and skill and the mentor by gaining understanding of how to negotiate learning outcomes with their mentoree. Ideally, both would learn how to sustain a collaborative interaction.)

A final example is taken from a primary school in which collaborative teams planned, developed, monitored and critically evaluated creative multimedia projects. These projects were learner centred with the learners asking the questions, seeking the answers, sharing their findings and setting further learning goals. Students, teachers and parents had interchangeable roles in the teaching and learning process.

Links to the Scales of Authentic Pedagogy

It is readily apparent that the examples above would reflect high scores on the Scales of Authentic Pedagogy, especially in the scale that has not so far been mentioned in connection with the previous models of learning - *the extent to which the lesson, activity or task is connected to competencies beyond the classroom.*

5.2.e. Summary

In this section, we have described our observations through the use of the Scales of Authentic Pedagogy and interpreted their meaning theoretically, using Bruner's (1996) models of minds of learners. We have noted that in many of the classrooms that we observed, there were low scores on the scales of our measuring instrument, but that some classrooms reflected the model of learning most recommended by Bruner. As we indicated earlier, there are many reasons for the scores attained here and we cannot assume that the single lesson that we saw from each teacher does reflect their everyday pedagogy.

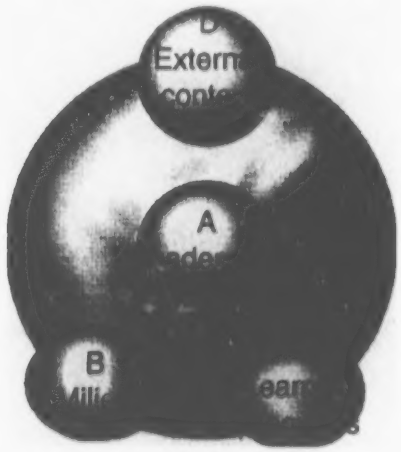
However, our *general* assumption in this section has been that teachers' beliefs about how their students learn *is* reflected in their pedagogy. If this assumption is correct, then it follows that teachers who are locked into apprenticeship and/or transmissive modes of teaching will also be locked into low scores on the Scales of Authentic Pedagogy and will rarely promote the kinds of learning, using ICT or other resources, that Newmann and Associates (1996) and Bruner (1996) see as authentic, transformative and exemplary.

A recommendation stemming from this section is that DET, through professional development, assists teachers to understand their tacit theories of learning and how their pedagogies stem from these beliefs. With such understanding, teachers can then make more informed choices about pedagogies using ICT that lead to exciting new and transformative opportunities for learning.

6. Analysis of the processes which underpin curriculum change related to the integration of computer-based technologies

In both the review of literature and our findings we have noted how the integration of CBL is closely connected with views of curriculum and pedagogy. Hence, effective CBL is dependent on effective curriculum change. To provide some insights into the change processes we observed in the participating schools we analyse the processes in this section utilising a framework developed by Scott (1999). He identifies four major areas that are relevant in the management of change. Figure 1 illustrates how these areas fit together.

Figure 1: Change management framework for education



Scott, 1999, p.17

According to Scott, the external context (marked as D in the diagram) and the internal context, which incorporates organisational or local influences (on the diagram labeled as B - Milieu) both play a role in triggering educational change. Changes in Learning Programs (bottom right, marked as C) can be enhancements

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of what exists or innovations. Scott suggests that educational changes do not occur spontaneously but need leadership (centrally placed in the figure and marked as A). Different people may take on the role of the leader depending on the context. Scott recommends that for effective change to occur:

> *Changes in B and C should be explicitly linked, with the initial focus on continuous improvement and innovation in learning programs and the implications for enhancements or innovations in milieu arising out of these learning developments. Changes in milieu which do not demonstrably add value to the quality of learning program design and delivery should be avoided. (Scott, 1999, p. 16)*

Scott emphasises that learning is not linear but cyclical. A major factor in any change process requires skill in "reading and matching". This approach suggests that while it is important to develop a range of learning options by considering processes that others have put into place, once they are placed in the particular context, changes and modifications might need to occur. The suggestion is that a plan of action needs to be developed which best fits local conditions, and to have choice of plans of actions it is necessary to have well developed knowledge of the learning tools and design options that are available. The implementation process then involves matching the tools and options to the context to get maximum "fit".

In the above Scott emphasises the importance of "reading and matching". Consequently, the multiple areas identified in Figure 1 have a bearing on the strategies and processes adopted by individual schools. The following discussion considers the elements of Scott's change management framework as delineated in Figure 1, with respect to the specific contexts of the participating schools.

6.1. External context

A major influence in all of the schools' adoption of computer-based learning has been the state government's push to ensure that each school has adequate hardware and reliable Internet access. The NSW DET's prioritising of CBL in the

curriculum and pedagogy has been another important aspect of the external context within which the participating schools operate. For example, many teachers have received basic training through the DET TILT (Technology In Learning Teaching) program. Additionally, increased access to, and general usage of, computers and the Internet in the wider community is another important external factor.

6.2. Milieu

Organisational structures that supported computer-based learning in the participating schools reflected a diverse range of local influences. These influences related to the schools' geographic locations, financial resources, technological resources, leadership structure, curriculum priorities and local professional development opportunities. For example, the combination of additional funding opportunities and an enthusiastic teacher helped to start the change process in a remote regional school. Elsewhere the support offered by the school and local community was instrumental in developing and implementing the school's technology plan. Some of the participating schools had previously received funding from the Focus School Project to develop projects in computer-based learning and these initiatives continued and expanded during the course of the study.

6.3. Learning Programs

A number of programs have been included in section 4.4 as rich descriptive examples of current usage. These programs describe learning opportunities which might not have occurred without the use of computer-based technologies. Some examples include:

- the production and publication of web-based, and other electronic resources, which could be used for educational purposes by a wider community;

- enhanced communication through email and other web-based communication tools;
- the development of technological competencies by students and teachers, such as the use of scanners and digital cameras, that enriches the production of learning materials.
- the provision of individual learning programs for students with special needs which enabled them to produce work samples that they could otherwise not produce.
- the opportunity to develop collegial learning communities in which students, teachers and parents have the opportunity to function as mentors. The communities extended across grades, age groups and bridged preschool/primary/secondary divide. For example, the whole school projects we described challenged traditional roles by placing students in the role of mentor/expert.

6.4. Leadership

Scott's emphasis on strong leadership is a key aspect of his change framework. This emphasis is supported by our observations in the participating schools. A variety of leadership models were observed, as detailed in section 4.1.b, including leadership by the school executive, a committee, or an enthusiastic teacher.

6.5. Recommendations

We propose the following additional recommendations based on this discussion of the CBL change process in the participating schools:

- Any strategic plan for implementation of CBL must take into account the contextual conditions of each school. Hence, any statewide plan for CBL must have the capacity for modification at the local level. This supports our contention (see Section 4.1.a) that schools need to develop

comprehensive Visions for Learning which incorporate the relationships between educational technologies and learning in locally developed school based programs.

- School leadership must be committed, supportive and prepared to provide resources to support the change process. (This recommendation from the change literature is highlighted in our findings - see 4.1.b.i). To support principals in their leadership in this area, we therefore recommend that they be given opportunities to investigate the new technologies and what these technologies can bring to their schools to enhance the learning.

- Funding opportunities should be made available for schools to resource their implementation of effective CBL. The case study schools made imaginative use of resources that they had (see 4.1.c), and in some cases, would not have been able to implement their technology plans if they had not had access to these resources.

- As enthusiastic adopters of effective CBL encourage those around them to investigate the new technologies, opportunities should be provided at a district level to allow such enthusiasts to reach a larger group of teachers than just in their school. A district network of teachers incorporating both enthusiasts and newcomers might be helpful. This recommendation complements our suggestion that teachers competent in the use of CBL are targeted for enhanced professional development (see section 4.4 recommendation).

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8. Appendices

8.1. Teacher Interview Schedule

School_____

Teacher_____ _Year/Subject____

No. Students_____No. Girls_____No. Computers_____

Software/Educational Technology _____

Observer_____Date_____

We would like to ask you some questions related to the integration of CBL in this class.

- How does the lesson we observed fit within your current program/ unit of work for this class?
- In what ways is this lesson typical of how you generally teach this class?
- Prompt: What strategies do you generally used that were used in today's lesson, eg classroom organisation, teaching/learning strategies, assessment, evaluation, resources?
- We would like to know how you began to implement CBL with this group?
- How do you perceive this integration has impacted on your teaching?
- How do you perceive this integration to have impacted on students' learning?
- What prompted you to start integrating computers-based learning into your lessons?
- What support is there for you in assisting the integration of CBL in your teaching?
- Can you sketch for us some of the issues associated with integrating CBL in your classroom?
- Do parents and the community have access to the technologies being used by the students? If so, in what ways and what was the driving force behind this?
- Do you see CBL as more suited to certain KLAs than to others? If so, which KLAs?
- What would you like to do in the future to further integrate CBL?

8.2. Classroom Observation Schedule

School_____

Teacher_____Year/Subject____

No. Students_____No. Girls_____No. Computers_____

Software/Educational Technology_____

Observer_____Date_____

DIMENSIONS

1.	To what extent do students use higher order operations?	1 2 3 4 5
2.	To what extent is deep knowledge presented?	1 2 3 4 5
3.	To what extent is classroom discourse devoted to creating or negotiating understanding of subject matter?	1 2 3 4 5
4.	To what extent is the lesson activity or task connected to competencies or concerns beyond the classroom?	1 2 3 4 5
5.	To what extent is the learning environment child-centred?	1 2 3 4 5

To what extent do student use higher order thinking

Lower Order Thinking occurs when students are asked to receive or recite factual information or to employ rules and algorithms through repetitive routines. Students are given pre-specified knowledge ranging from simple facts and information to more complex concepts. Such knowledge is conveyed to students through a reading, work sheet, lecture or other direct instructional medium. The instructional process is to simply transmit knowledge or to practice procedural routines. Students are in a similar role when they are reciting previously acquired knowledge; i.e., responding to test-type questions that require recall of pre-specified knowledge. More complex activities still may involve reproducing knowledge when students only need to follow pre-specified steps and routines or employ algorithms in a rote fashion.

Higher Order Thinking requires students to manipulate information and ideas in ways that transform their meaning and implications. This transformation occurs when students combine facts and ideas in order to synthesise, generalise, explain, hypothesise or arrive at some conclusion or interpretation. Manipulating information and ideas through these processes allows students to solve problems and discover new (for them) meanings and understandings. When students engage in the construction of knowledge, an element of uncertainty is introduced into the instructional process and makes instructional outcomes not always predictable; i.e., the teacher is not certain what will be produced by students. In helping students become producers of knowledge, the teacher's main instructional task is to create activities or environments that allow them opportunities to engage in higher order thinking.

HIGHER ORDER THINKING

Lower order thinking 1 . . . 2 . . . 3 . . . 4 . . . 5 Higher order thinking

1=	Students are engaged only in lower order thinking; i.e., they either receive, or recite, or participate in routine practice and in no activities during the lesson do students go beyond simple reproduction.
2=	Students are primarily engaged in lower order thinking, but at some point they perform higher order thinking as a minor diversion within the lesson.
3=	Students are primarily engaged in routine lower order thinking a good share of the lesson. There is at least one significant question or activity in which some students perform some higher order thinking.
4=	Students are engaged in an at least one major activity during the lesson in which they perform higher order thinking, and this activity occupies a substantial portion of the lesson and many students are engaged in this portion of the lesson.
5=	Almost all students, almost all of the time, are engaged in higher order thinking.

To what extent is deep knowledge presented?

Knowledge is shallow, thin or superficial when it is not connected with significant concepts or central ideas of a topic or discipline, and it is dealt with only in an algorithmic or procedural fashion. Knowledge is also shallow when important, central ideas have been trivialised by the teacher or students, or when it is presented as non-problematic. This superficiality can be due, in part, to instructional strategies such as when teachers cover large quantities of fragmented ideas and bits of information that are unconnected to other knowledge.

Knowledge is deep or thick when it concerns the central ideas of a topic or discipline and because such knowledge is judged to be crucial to a topic or discipline. Knowledge is deep when relatively complex relations are established to central concepts.

NOTE: In scoring this item, observers should note that depth of knowledge refers only to the substantive character of the content that either students or teachers present in the lesson.

DEPTH OF KNOWLEDGE

Knowledge is shallow 1...2...3...4...5 Knowledge is deep

_1=Almost all of the lesson's content knowledge is very thin because it does not deal with significant topics or ideas.

_2=Knowledge remains superficial, but some key complex concepts and ideas are mentioned or covered by the teacher or students on a superficial or trivialised level.

_3=Knowledge is treated unevenly during instruction; i.e., deep knowledge of something is countered by superficial understanding of other knowledge. At least one significant idea may be presented in depth, but in general the focus is not sustained.

_4=Most of the presented knowledge is relatively deep because either the teacher or the students provide information, arguments or reasoning that demonstrate the complexity of an important idea. Sustained focus on central content is occasionally interrupted by thin knowledge coverage.

_5=Knowledge is very deep because almost all knowledge presented in the lesson sustains focus on a significant topic, and does so either through a complex structure or by demonstrating the problematic nature of information and/or ideas.

To what extent is classroom discourse devoted to creating or negotiating understandings of subject matter?

In classes where there is little or no substantive conversation, teacher-student interaction typically consists of a lecture with recitation where the teacher deviates very little from delivering information and routine questions; students typically give very short answers. Discussion here may follow the typical IRE (initiate/response/evaluate) pattern: with low level recall/fact based questions, short utterance or single word responses, and further simple questions and/or teacher evaluation statements (e.g., "yes, good"). This is an extremely routine, teacher centred pattern, that amounts to a "fill in the blank", or "guess what's in the teacher's head" format.

In classes with substantive conversation there is considerable teacher-students and student-student interaction about the ideas of a substantive topic; the interaction is reciprocal, and it promotes coherent shared understanding. This scale assesses the extent of talking to learn and to understand in the classroom.

Substantive conversations includes the features below:

A. INTELLECTUAL SUBSTANCE: The talk is about subject matter in the discipline and encourages critical reasoning such as making distinctions, applying ideas, forming generalisations, raising questions. It moves beyond just the recounting of experiences, facts, definitions, or procedures (e.g., technical language, analytical distinctions and categories being made, levels or differentiations between types and arguments stated, grounds for disagreement stated).

B. DIALOGUE: The conversation involves sharing of ideas and is not completely scripted or controlled by one party (as in teacher-led recitation). Sharing is best illustrated when participants provide extended statements, direct their comments, questions and statements directly to others, redirect and select next speakers.

C. LOGICAL EXTENSION AND SYNTHESIS: The dialogue builds coherently on participants' ideas to promote improved collective understanding of a theme or topic. In short, substantive conversation resembles the kind of sustained exploration of content characteristic of a good seminar where student contributions lead to shared understandings (e.g., teachers and students may make principled topic shifts, may use linking words, make explicit references to previous comments, and may summarise).

D. A SUSTAINED EXCHANGE extends beyond a routine IRE. This can occur between teacher and students or student and student and involves several consecutive interchanges. Dialogue consists of a sustained and topically related series of linked exchanges between speakers.

NOTE: Do not code individuals' monologues. To score 2 or above, conversation must focus on matters of substance.

SUBSTANTIVE CONVERSATION (continued)

SUBSTANTIVE CONVERSATION

No 'sub-con' 1. . . 2. . . 3. . . 4. . . 5 Sustained 'sub-con'

1=	Virtually no features of substantive conversation occur during the lesson. Lesson consists principally of either a sustained teacher monologue/lecturer and/or a repeated IRE sequence with little variation, or conversation which is not substantive.
2=	Features B (DIALOGUE) and/or C (LOGICAL EXTENSION & SYNTHESIS) occur briefly and involve at least ONE SUSTAINED EXCHANGE.
3=	Features B (DIALOGUE) and/or C (LOGICAL EXTENSION & SYNTHESIS) occur and involve TWO OR MORE SUSTAINED EXCHANGES.
4=	All features of substantive conversation occur, with sustained exchanges over almost ONE HALF OF THE LESSON, with both teachers and students scaffolding the conversation.
5=	All features of substantive conversation occur in an ongoing and sustained fashion, extending across almost ALL OF THE LESSON, with both teachers and students scaffolding the conversation.

To what extent is the learning environment student-centred?

A student-centred learning environment is present when the teacher works in the role of support and collaborator, actively coaching students to explore, discover and create unique solutions to learning problems. Students participate at times as the expert/knowledge provider as they are encouraged to use their personal knowledge develop and pose their own questions, gather and evaluate information for themselves, and explore their own alternative ways of finding out answers. The teacher participates at times as one who may not know it all but desires to learn.

A teacher-centred learning environment is present when the students are passive learners. The teacher is the primary source of information, always asks questions and controls the focus of student learning. The teacher directs students through pre- set step-by-step exercises so that all achieve similar results. The student is always in the role of learner, receiving all information and directions from the teacher.

CHILD CENTRED LEARNING ENVIRONMENT

Teacher-centred environment 1.....2.....3.....4.....5 Child-centred environment

1	= The learning environment is teacher-centred. Teachers controls focus of student learning, giving all information and asking all questions. Students are passive learners, work through step by step procedures and achieving similar end products.
2	The learning environment is primarily teacher-centred however students are given a minor opportunity for decision making, eg choosing font and number of columns to work in.
3	The learning environment is primarily teacher-centred however there is one significant activity built into lesson which allows students to explore and search for unique learning solutions. The students know what is to be learnt rather than just the task at hand.
4	The learning environment is primarily child-centred. The teacher coaches and challenges students to come up with creative solutions to learning problems. There is opportunity for peer tutoring and the sharing of discoveries. The teacher provides scaffolding however; direct instruction is a minor part of the lesson.
5	The learning environment is child-centred. The teacher acts as collaborator, supporting students in their exploration of unique solutions to learning problems. Students are encouraged to use their personal knowledge, pose their own questions and find alternative ways of finding answers.

To what extent is the lesson, activity or task connected to competencies beyond the classroom?

This scale measures the extent to which the class has value and meaning beyond the instructional context. In a class with little or no value beyond, activities are deemed important for success only in school (now or later), but for no other aspects of life. Student work has no impact on others and serves only to certify their level of competence or compliance with the norms and routines of formal schooling.

A lesson scores higher on this dimension the more there is a connection to the larger social context within which students live. Two areas in which student work can exhibit some degree of connectedness are: (a) a real world public problem; i.e., students confront an actual contemporary issue or problem, such as applying statistical analysis in preparing a report to the City Council on the homeless; (b) students' personal experiences; i.e., the lesson focuses directly or builds upon students' actual experiences or situations. High scores can be achieved when the lesson entails one or both of these.

CONNECTEDNESS TO THE WORLD BEYOND THE CLASSROOM

No connection 1 . . . 2 . . . 3 . . . 4 . . . 5 Connected

1= Lesson topic and activities have no clear connection to anything beyond itself; the teacher offers no justification beyond the need to perform well in class.

2= Students encounter a topic, problem or issue that the teacher tries to connect to students' experiences or to contemporary public situations; i.e., the teacher informs students that there is potential value in the knowledge being studied because it relates to the world beyond the classroom. Eg students are told that understanding Middle East history is important for politicians trying to bring peace to the region; however, the connection is weak and there is no evidence that students make the connection.

3= Students study a topic, problem or issue that the teacher succeeds in connecting to students' actual experiences or to a contemporary public situation. Students recognise some connection between classroom knowledge and situations outside the classroom, but they do not explore the implications of these connections which remain abstract or hypothetical. There is no effort to actually influence a larger audience.

4= Students study or work on a topic, problem or issue that the teacher and students see as connected to their personal experiences or actual contemporary public situations. Students recognise the connection between classroom knowledge and situations outside the classroom. They explore these connections in ways that create personal meaning and significance for the knowledge. However, there is no effort to use the knowledge in ways that go beyond the classroom to actually influence a larger audience.

5= Students study or work on a topic, problem or issue that the teacher and students see as connected to their personal experiences or actual contemporary public situations. Students recognise the connection between classroom knowledge and situations outside the classroom. They explore these connections in ways that create personal meaning and significance for the knowledge. This meaning and significance is strong enough to lead students to become involved in an effort to affect or influence a larger audience beyond their classroom in one of the following ways: by communicating knowledge to others (including within the school), advocating solutions to social problems, providing assistance to people, creating performances or products with utilitarian or aesthetic value.

8.3. Sample letter to principals

Dear,

The Change in Education Research Group from the University of Technology, Sydney (UTS) has been selected by the Department of Education and Training (DET) to conduct the *Research into the Integration of Computer-based Learning in Schools Project*.

We are writing to ask you to consider being one of the six case study schools to take part in this project because of the ways your school has integrated computer based learning in the curriculum. By studying and describing this process at your school we hope to provide DET with information on how to support this process and to assist other schools that have not yet managed to effect the same quality of computer-integrated learning.

We would like to conduct an in-depth visit to your school over approximately two days in February, 2000. On this visit we would like to gather data through classroom observations using an observation instrument that has been especially developed for this study. We would also like to interview key personnel such as students, teachers, parents and other stakeholders. The interviews will take place at your school and will be of about 30 minutes duration.

In the interviews, participants will be asked to discuss their experiences related to the integration of computer-based learning. There is a risk here, that participants may reveal information that is confidential. In this regard, participants may be assured that, unless permission is given, they will not be identifiable and that any data will be removed from transcripts that participants feel is identifying or embarrassing.

Thank you for your consideration of this matter and we hope you will agree to the participation of your school in this important research project. If you have any questions, you are very welcome to contact me by phone or by email.

Yours sincerely,

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[i] We gratefully acknowledge the expertise of Dr Mark Bahr (University of Queensland) who provided the statistical comparisons with the Queensland School Reform Longitudinal Study.

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